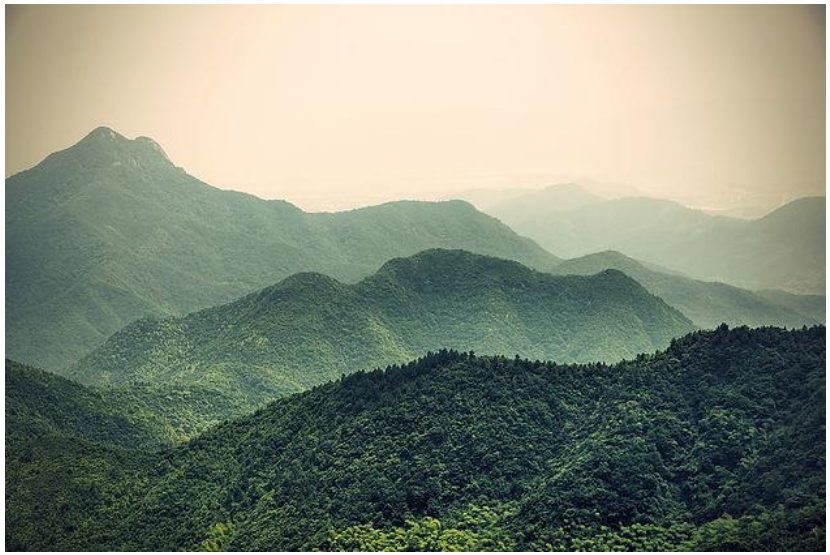
Valuation of forest ecosystem and hydroelectric power generation



VS

Introduction

- Scenario 1: Forest land as natural park
- Scenario 2: Dam construction for power generation

Considerations:

- Area of watershed: 100 km^2
- Area submergence due to dam: 90 km^2
- Height of the dam: 100 m
- Biome: Doon valley, Uttarakhand

Benefits Identified

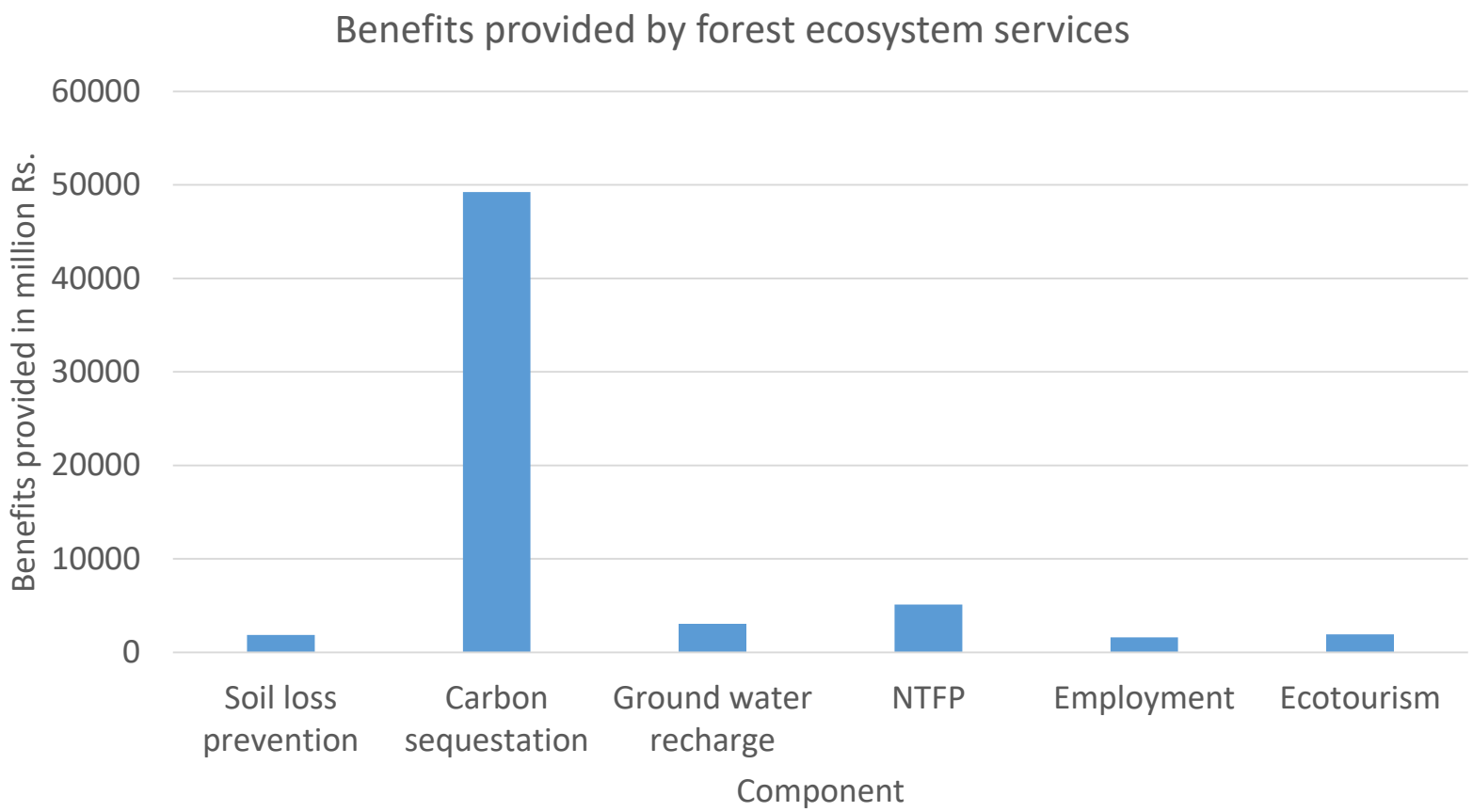
Forest land as natural park

- Soil loss prevention
- Non-timber forest products
- Ecotourism
- Employment opportunity
- Water provisioning (ground water recharge)
- Carbon sequestration

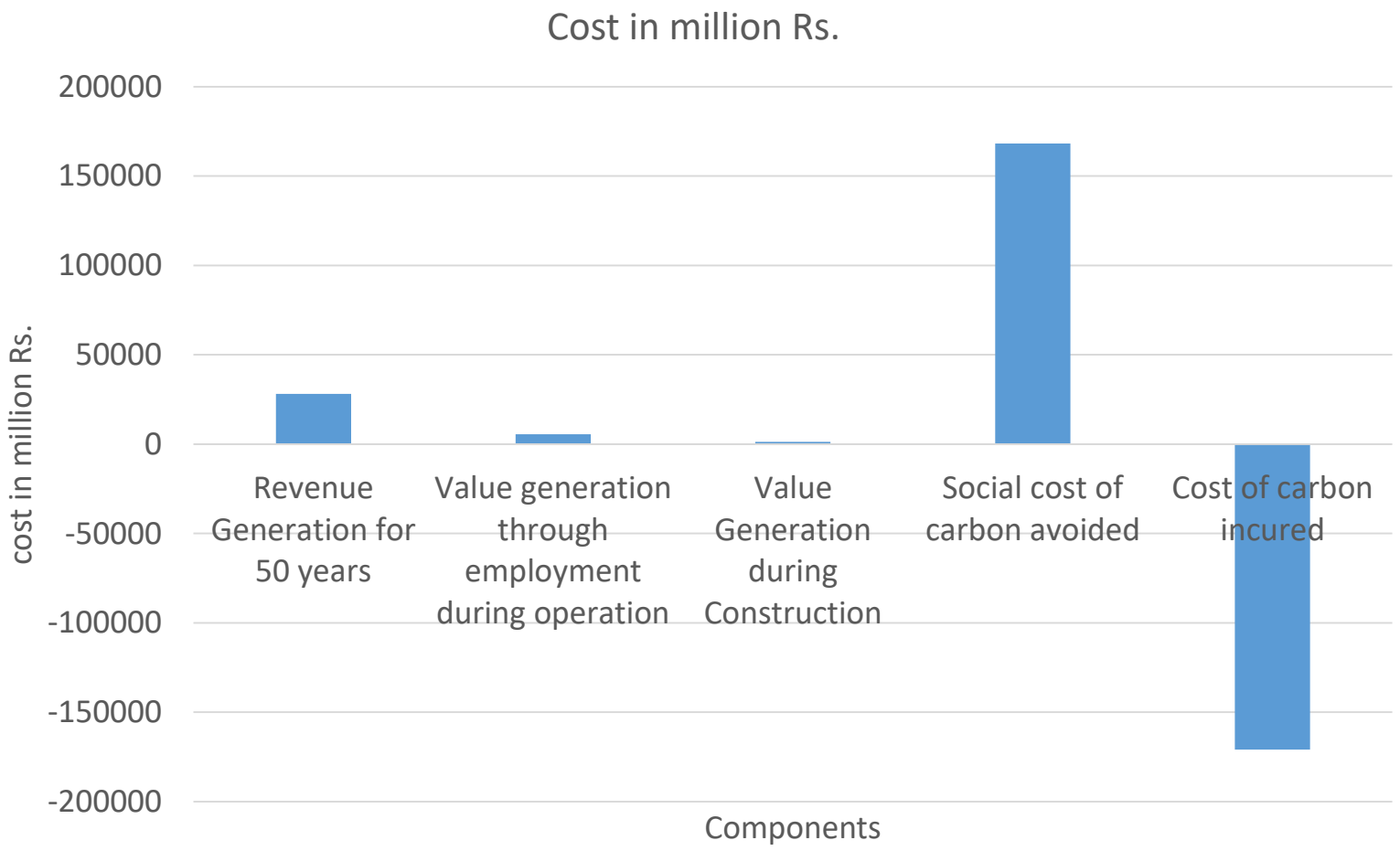
Hydroelectric power plant

- Revenue generation
- Social cost of carbon avoided
- Employment opportunity during construction
- Employment opportunity during operation

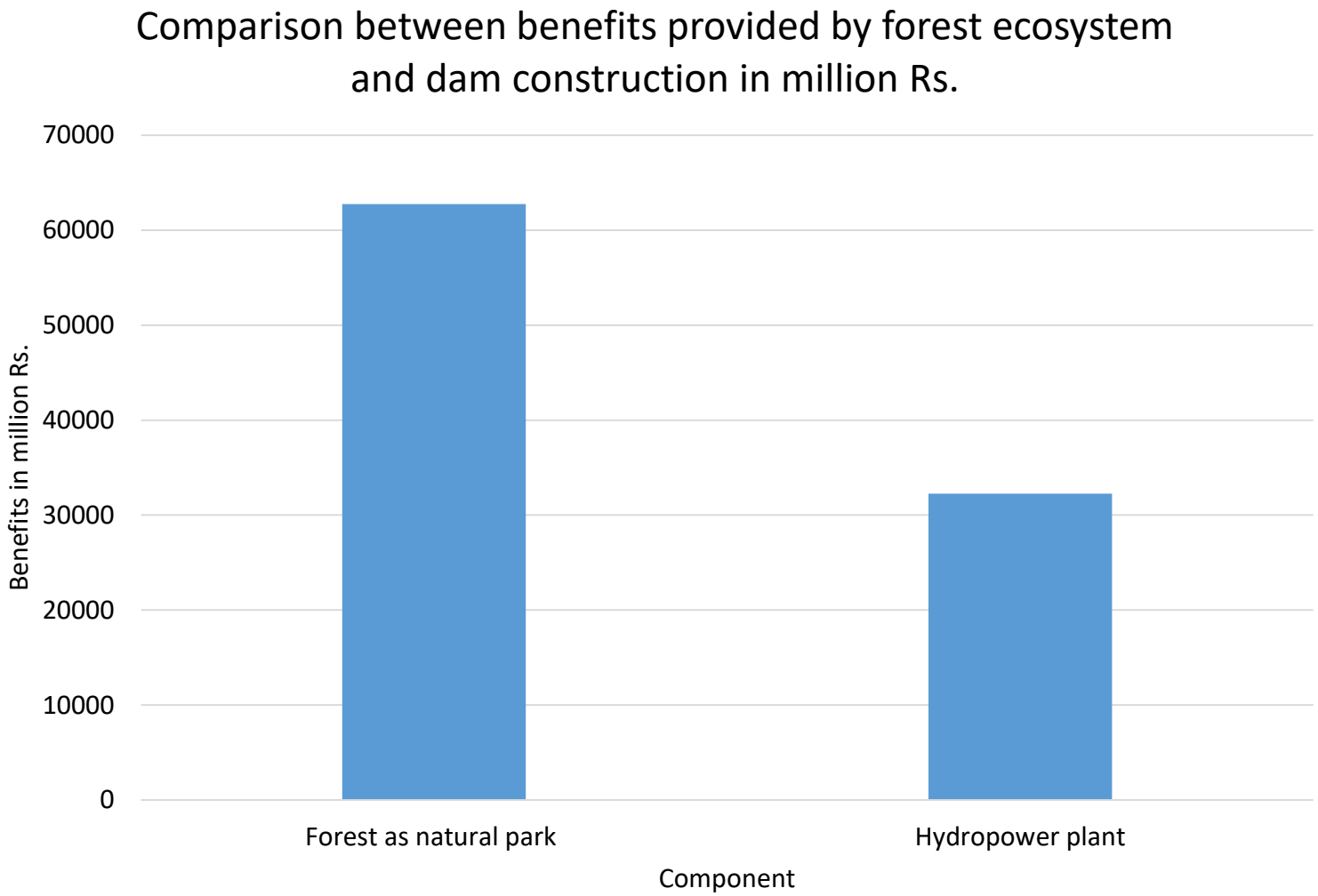
Benefits Provided by Forest Ecosystem



Benefits Provided by Hydroelectric Power Plant



What alternative to choose??



Methodologies

For quantification of impact

Soil Loss Prevention due to Forest Ecosystem

Methodology: The USLE equation is used to calculate the soil loss prevention.(Monograph 7)

Valuation: Replacement cost method which calculates the values of N, P, K and organic carbon lost due to soil loss is calculated according to market prices in 2003.

Data and assumptions

Values taken from monograph 7. The average inflation rate is taken at 6.7% to inflate values to 2017. The inflation rate of 2% is taken to extrapolate data till 2067. The justification being that soil loss prevention service will not have a very high inflation rate.

- A discount rate of 1.3% is taken (stern review)

Results

- The total soil loss in 2003 was 125.7 million kg (Monograph 7)
- The value of soil loss prevention in 2017 is 30.4 million rupees.
- After inflation in 2067 the value is 81.92 million rupees. After discounting this value would be 43.5 million rupees

NTFP(Non timber forest products)

Methodology

- Take flow value of NTFP for Uttarpradesh in 2001 from monograph 1
- Calculate present flow value of NTFP 2000-2067 by applying average inflation rate 6.7% over the past year from 2000-2017
- Apply discount rate of 1.4% on calculated flow value of NTFP for each year

Assumption

- All area covered by Doon valley is in Uttarpradesh.
- Average Inflation rate is same for 2017-2067 as 2000-2017
- No logging activity has occurred from 2000 to 2067

Results

Present values of NTFP (in 2017) = 21.5 million Rs.

Discounted flow value after 50 years (in 2067)= 274.58 million Rs.

Eco-tourism

Methodology used

- **Travel Cost**
- Data from Monograph 4
- Sikkim National Park (similar biome) – **Benefit transfer**
- Consumer surplus (added value of ecotourism in 2003): **104.6** Rs per person
- Application of an average **inflation rate of 6.7%**

Assumption

- Number of visitors at the opening of the Park in 2017: 5000 persons
- Growth rate in ecotourism specific to national parks in India (2017): **15%** (source: conservationindia.org)

Results

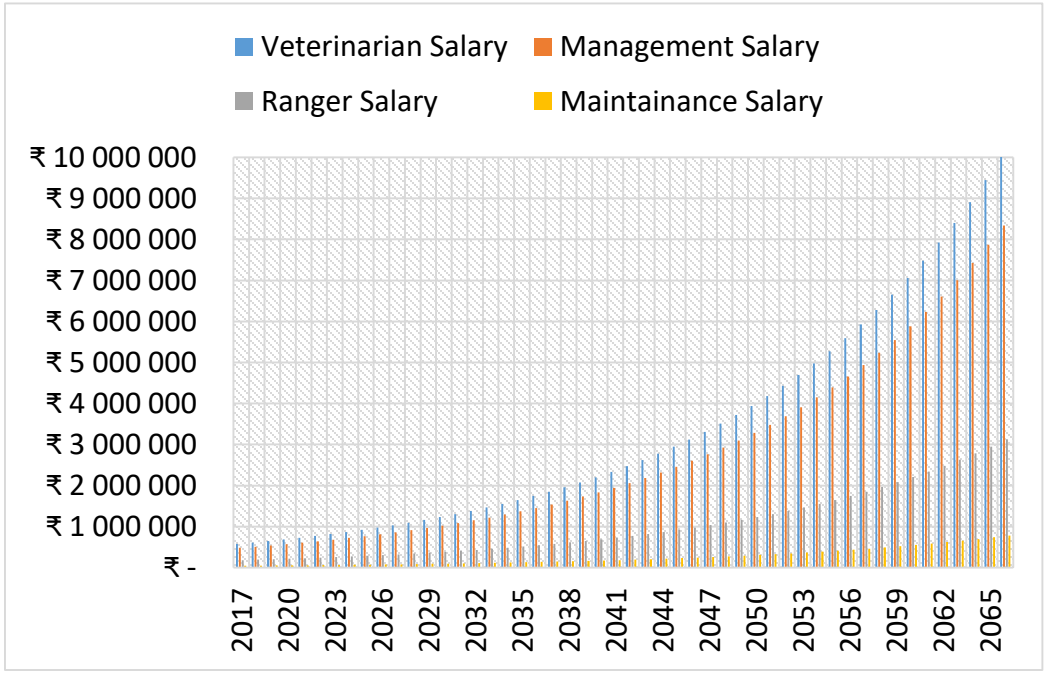
- **Added value of ecotourism over the period 2017-2067:** ajusted value with an average ecotourism growth rate of **5%**: **14,867,484 Rs**
- **PNV** with a **discount rate** of **1.5%**: 14,867,484/(1.015)^50= 7,062,124 Rs;

(NB: justification for choosing discount rate: public good, in future, less availability of land for ecoparks)

National Park Generates Employment for Many

- Potential for employment of up to 60 people.
  - 1 Veterinarian (Base Salary ₹576,000)
  - 13 Management level positions (Base Salary ₹480,000)
  - 16 Park Rangers (Base Salary ₹180,000)
  - 30 Maintenance and Ground (Base Salary ₹45,000)

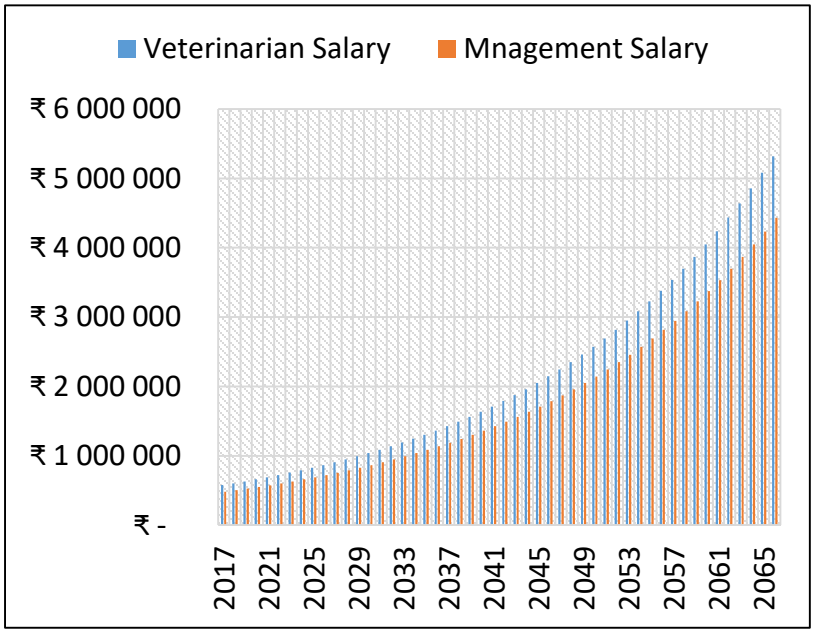
- Expected salaries to increase throughout 50 year span as a result of wage inflation.



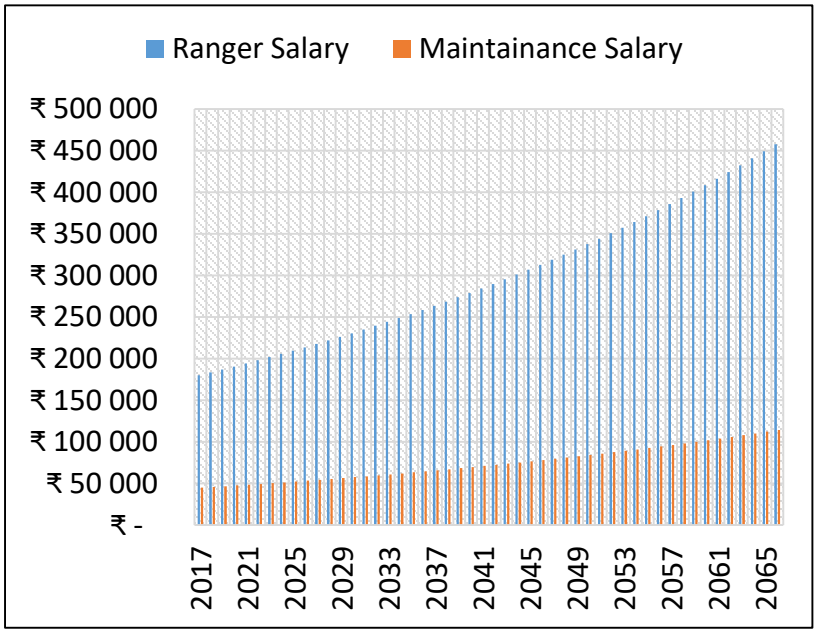
Conti..

- Two separate discount rates are applied to calculate future salaries into present values.
- 1.3% is applied to Veterinarian and Management salaries
- 4% is applied to Park Ranger and Maintenance salaries
- This is due to large differences in salary levels altering worker's present value.

Worker's Expected Present Salary (Discount Rate 1.3%)



Worker's Expected Present Salary (Discount Rate 4%)



Conti..

- Total Discount Value created for employment in the national park is ₹1,523,000,000
- Giving worker's the opportunity to better improve their standard of living as well as the ability to preserve the ecosystem of the park.

	Veterinarian	Management	Park Ranger	Maintenance Staff	Total
Total Discount Value per worker	₹107,000,000	₹90,000,000	₹15,000,000	₹4,000,000	
Number of workers	1	13	16	30	60
Total Discount Value	₹107,000,000	₹1,170,000,000	₹240,000,000	₹120,000,000	₹1,637,000,000

Ground Water Recharge

Methodology

- **P=E+R+F+GW (water balance method)**

  where,

  P= Precipitation (annual 1147 mm for Uttarakhand)

  E= Evapotranspiration in mm for a yr. (considered for forest cover)

  R= RUNOFF in mm

  F= Root constant forest area in mm
- Financial cost of water= 0.3 Rs. Per m^3

Assumptions

- Runoff same for all catchment area
- Same rainfall intensity all over catchment
- Ground water recharge capacity of the area is not changing with time
- Cost of the water for all purposes is same
- Discount rate: 1.4 % (natural source, scarcity and need for future generation)
- Inflation rate: 6.7 % (averaged since last decade)

Results

- Total stock generated during 50 years= 3049 million rupees
- Financial cost of water is 5.1 million whereas opportunity cost is 77.4 million rp

Ref: Values and formula are considered for Uttarakhand for monograph 7

Hydroelectric Power Generation

Assumptions

- Flow- 1,00,000 m3/sec
- G= 9.81 m/s2
- Efficiency of the system= 0.9, Efficiency of the turbines= 0.5

Power available (P_{th})= μ*ρ*q*g*h

Where,

P_{th} = power theoretically available (W)

ρ = density (kg/m^3) (~ 1000 kg/m^3 for water)

q = water flow =(100000) (m^3/s)

g = acceleration of gravity 9.81 (m/s^2)

h = falling height =(100) (m)

μ = Efficiency (0.9)

Energy generated (MWh)= Power generated in a year (MW)* time (hr.)

Emission factors for different pollutants

CO_2 emission factors in the range of	0.969	kg/kWh
SOX	8.763	g/kWh
NOX	2.37	g/kWh
Methane from hydro reservoir	2000	gCO_2/kWh
Methane from thermal power plant	1000	gCO_2/kWh