RATIONAL AND SUSTAINABLE UTILIZATION OF FOREST RESOURCES WITH CONSIDERATION OF RECREATION AND TOURISM, BIOENERGY, THE GLOBAL WARMING PROBLEM, PAPER PULP AND TIMBER PRODUCTION: - A MATHEMATICAL APPROACH

ECOLOGICAL TOURISM: TRENDS AND PERSPECTIVES
OF DEVELOPMENT IN THE GLOBAL WORLD
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SAINT-PETERSBURG STATE FOREST TECHNICAL ACADEMY
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1. Rational coordination of the decisions in the forest industry, infrastructure, energy industry, recreation and tourism sectors, with consideration of climatic effects





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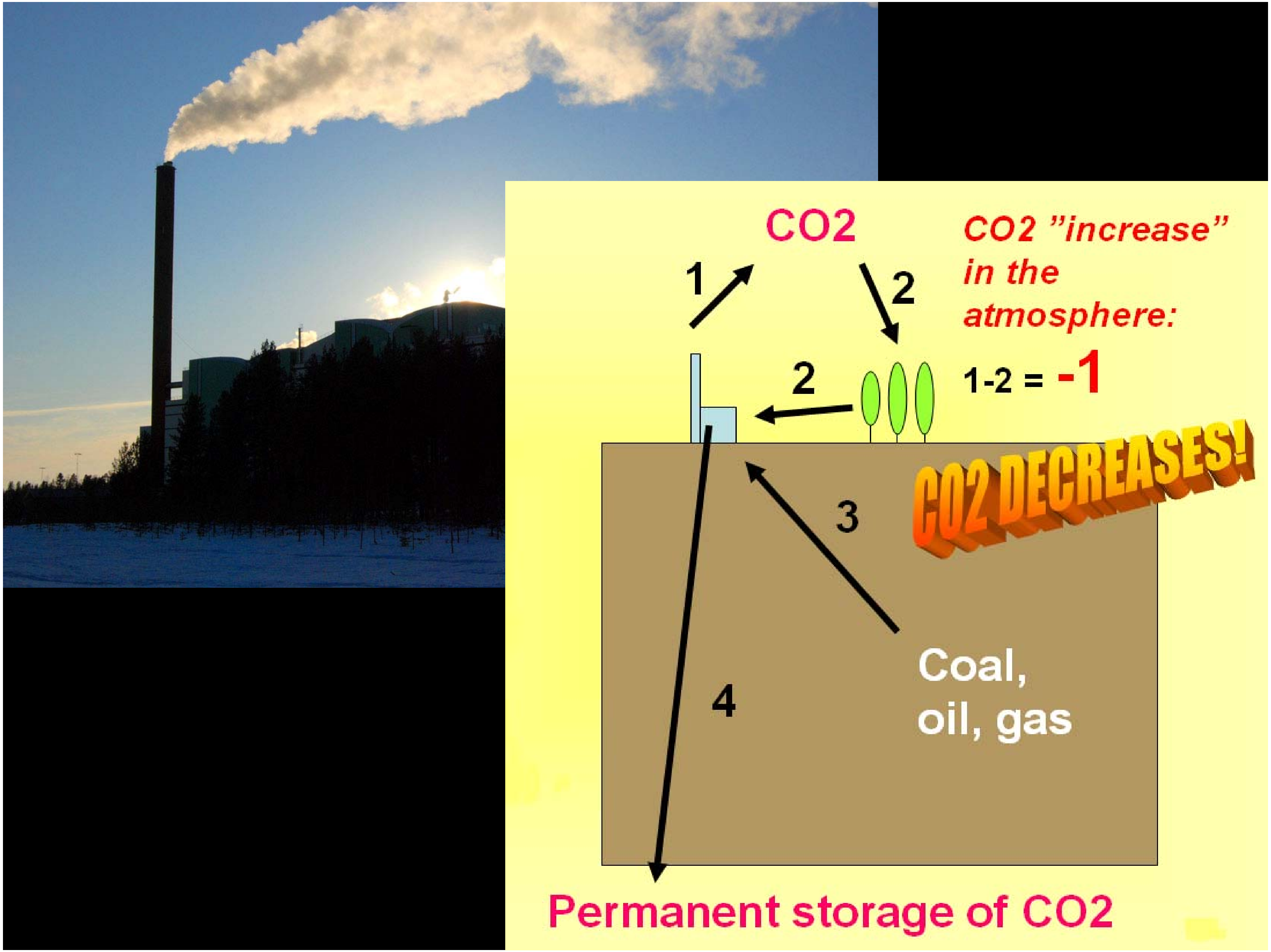

CO2
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2
CO2 "increase" in the atmosphere:
1-2 = -1
CO2 DECREASES!
3
4
Coal, oil, gas
Permanent storage of CO2

Let the activities in the sectors “forestry and forest industry”, infrastructure, energy, and recreation (including tourism), be denoted **F**,**I**,**E**& **R** . We also consider the future climate, **C**.

$$U = U(F, I, E, R, C)$$

U is the total utility

Let the present values of the profits in the sectors be denoted

$$\Pi_F(F), \Pi_I(I), \Pi_E(E), \Pi_R(R)$$

$$\Pi = \Pi_F(F) + \Pi_I(I) + \Pi_E(E) + \Pi_R(R)$$

One computationally feasible, but certainly not *completely* general, alternative to the very general problem of maximizing U is to try to maximize W.

$$W = \Pi(F, I, E, R) + \Phi(C(F, I, E, R))$$

1.1 Forest sector optimization

$$\Pi_F^* = \max_F \Pi_F(F)$$

$$s.t.\ F \in S_F(a, I_0)$$

1.2 Forest sector and infrastructure optimization

$$\max_{F,I} \Pi_{FI} = \Pi_F(F) + \Pi_I(I)$$

$$s.t. (F, I) \in S_{FI}(a)$$

1.3 Forest sector, infrastructure and energy optimization

$$\max_{F,I,E} \Pi_{FIE} = \Pi_F(F) + \Pi_I(I) + \Pi_E(E)$$

$$s.t.\ (F, I, E) \in S_{FIE}(a)$$

1.4 Forest sector, infrastructure and energy optimization plus conditional free access recreation valuation

$$\Pi = \Pi^*_{FIE} + \Pi_R(R_M(a, F, I, E))$$

$$\Pi^*_{FIE} = \max_{F,I,E} \Pi_{FIE} = \Pi_F(F) + \Pi_I(I) + \Pi_E(E)$$

$$s.t. (F, I, E) \in S_{FIE}(a)$$

1.5 Forest sector, infrastructure, energy and conditional free access recreation optimization

$$\max_{F,I,E} \Pi = \Pi_F(F) + \Pi_I(I) + \Pi_E(E) + \Pi_R(R_M(a,F,I,E))$$

$$s.t.\ (F,I,E) \in S_{FIE}(a)$$

1.6 Forest sector, infrastructure, energy and recreation optimization

$$\max_{F,I,E,R} \Pi = \Pi_F(F) + \Pi_I(I) + \Pi_E(E) + \Pi_R(R)$$

$$s.t. \ (F, I, E, R) \in S(a)$$

2. Proof that wild tourism is not economically optimal

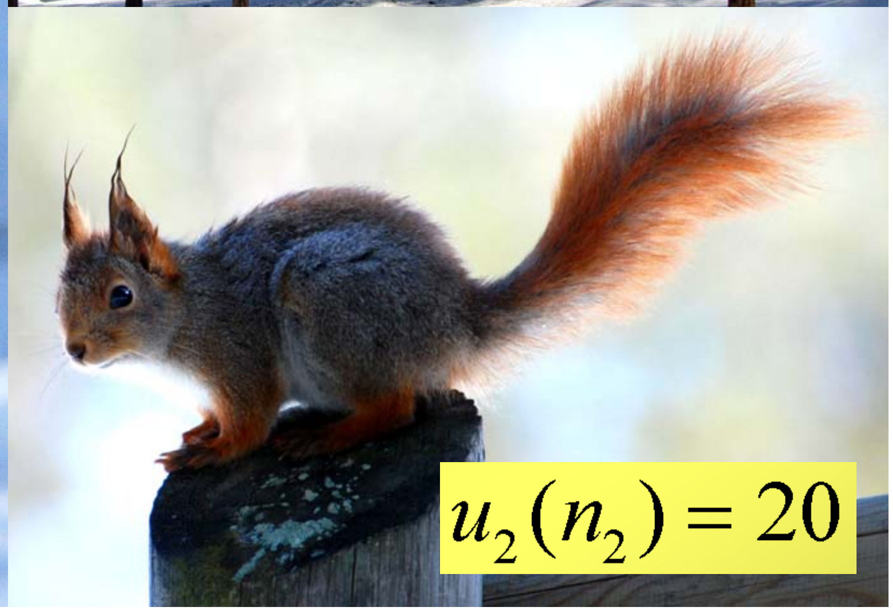
$$U = u_1(n_1)n_1 + u_2(n_2)n_2$$

$$n_1 + n_2 = 20$$

$$u_1(n_1) = 200 - 20n_1$$

$$u_2(n_2) = 20$$

$$u_1(n_1) = 200 - 20n_1$$



$$u_2(n_2) = 20$$

2.1. The case of free access ("Wild tourism")

With free access to both areas, every individual will independently select destination.

If $u_1(n_1) > u_2(n_2)$, n_1 increases and n_2 decreases until $u_1(n_1) = u_2(n_2)$.

If $u_1(n_1) < u_2(n_2)$, n_1 decreases and n_2 increases until $u_1(n_1) = u_2(n_2)$.

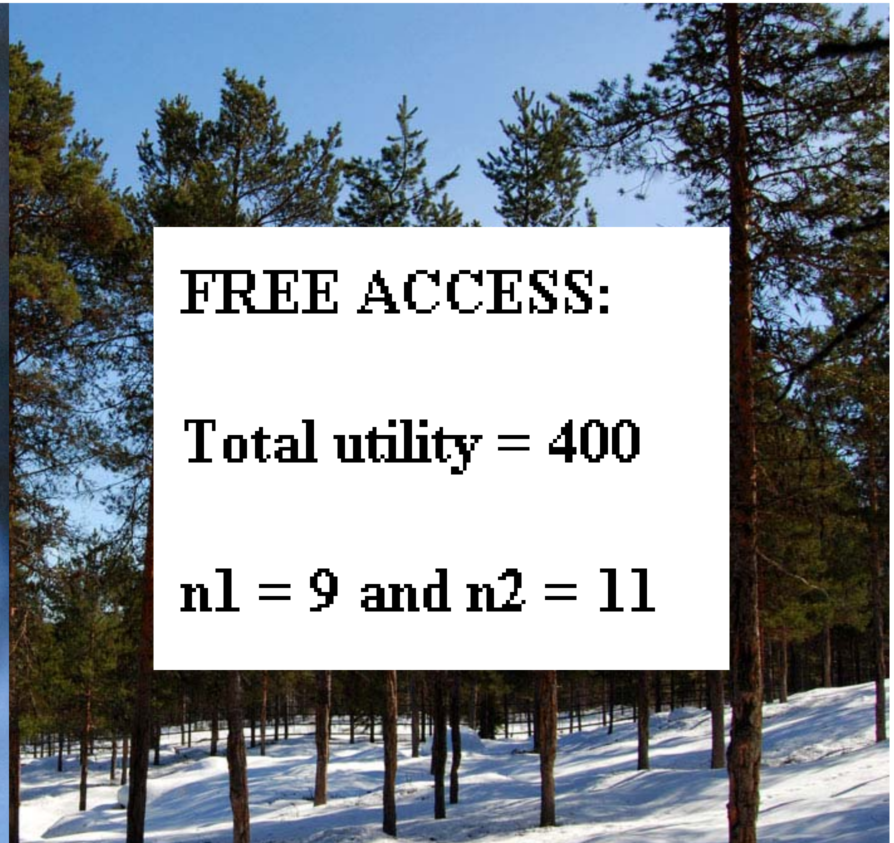
In spatial equilibrium,

$u_1(n_1) = u_2(n_2) = 20$ and

$$U = 20 * 20 = 400$$

In spatial equilibrium,

$$[200 - 20n_1 = 20] \Rightarrow (n_1 = 9) \Rightarrow (n_2 = 11)$$


FREE ACCESS:
Total utility = 400
n1 = 9 and n2 = 11

2.2. The case of optimally controlled tourism

$$\max_{n_1} U = u_1(n_1)n_1 + u_2(n_2(n_1))n_2(n_1)$$

$$\max_{n_1} U = (200 - 20n_1)n_1 + 20(20 - n_1)$$

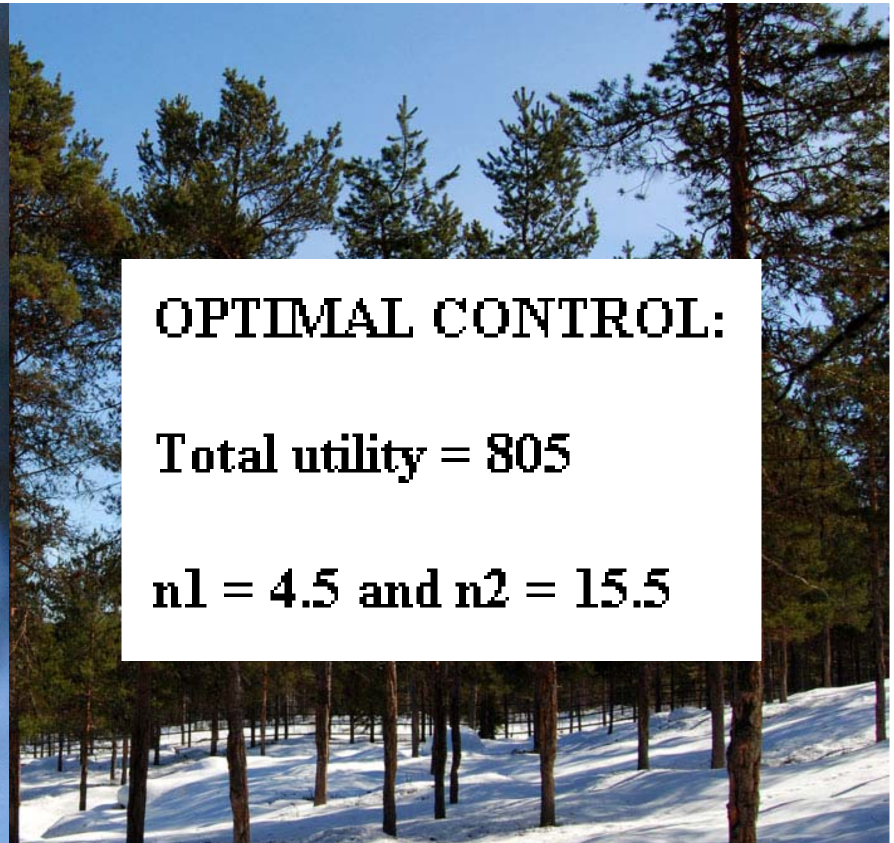
$$\max_{n_1} U = 400 + 180n_1 - 20n_1^2$$

$$\left(\frac{dU}{dn_1} = 180 - 40n_1 = 0\right) \Rightarrow n_1 = 4.5$$

$$\frac{d^2U}{dn_1^2} = -40 < 0$$

Hence, the derived optimum will be a unique maximum.

$$U^* = \max_{n_1} U = 400 + 180n_1 - 20n_1^2 = 805$$



OPTIMAL CONTROL:

Total utility = 805

n1 = 4.5 and n2 = 15.5

Conclusions

- Sustainable utilization of the forest resources of our planet is necessary for our survival.
- The resources can be used in many different ways, and for several purposes, that all are important to a sustainable world.
- Forest management decisions influence the value of the forest for recreation and tourism and, at the same time, changes the flow of bioenergy, the flow of timber and pulpwood, the economic results and the effects on the global warming problem.

- **For this reason, recreation and tourism should not be studied in isolation. They should, and can, be optimized as a part of the total system, with consideration also of “forestry and forest industry”, infrastructure, energy and climate.**





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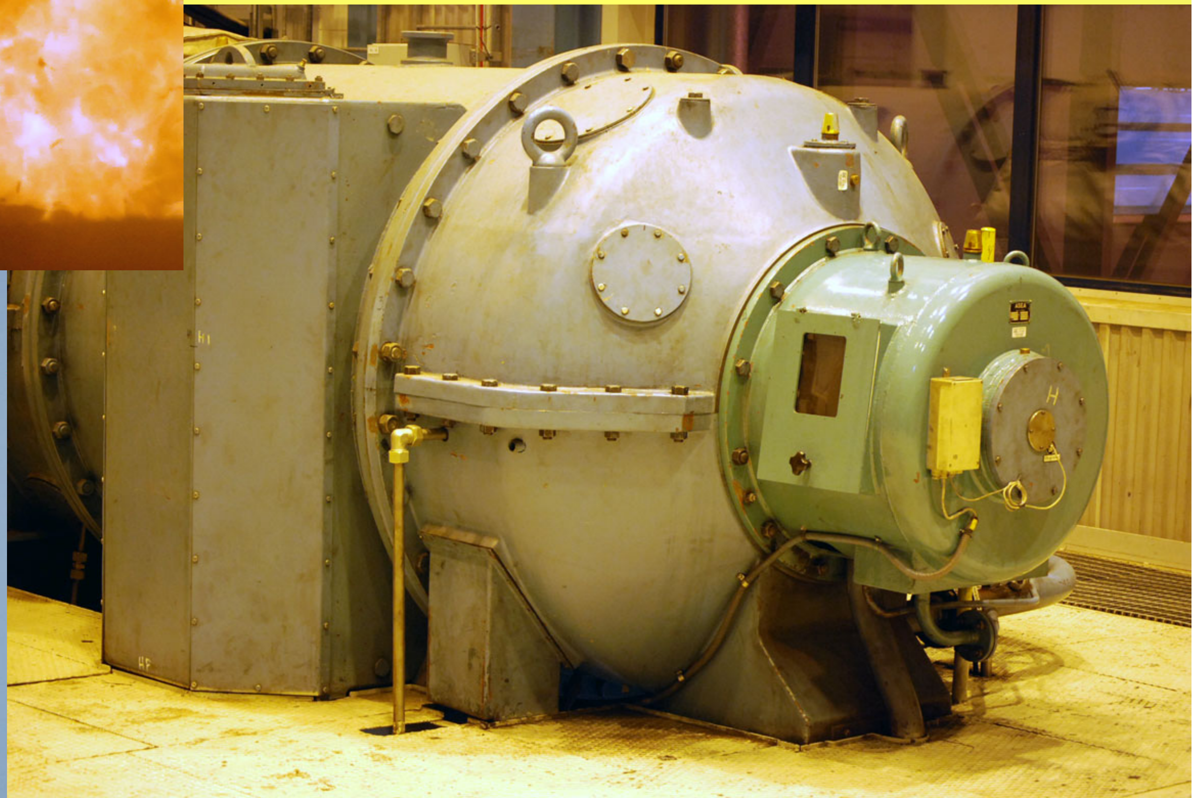


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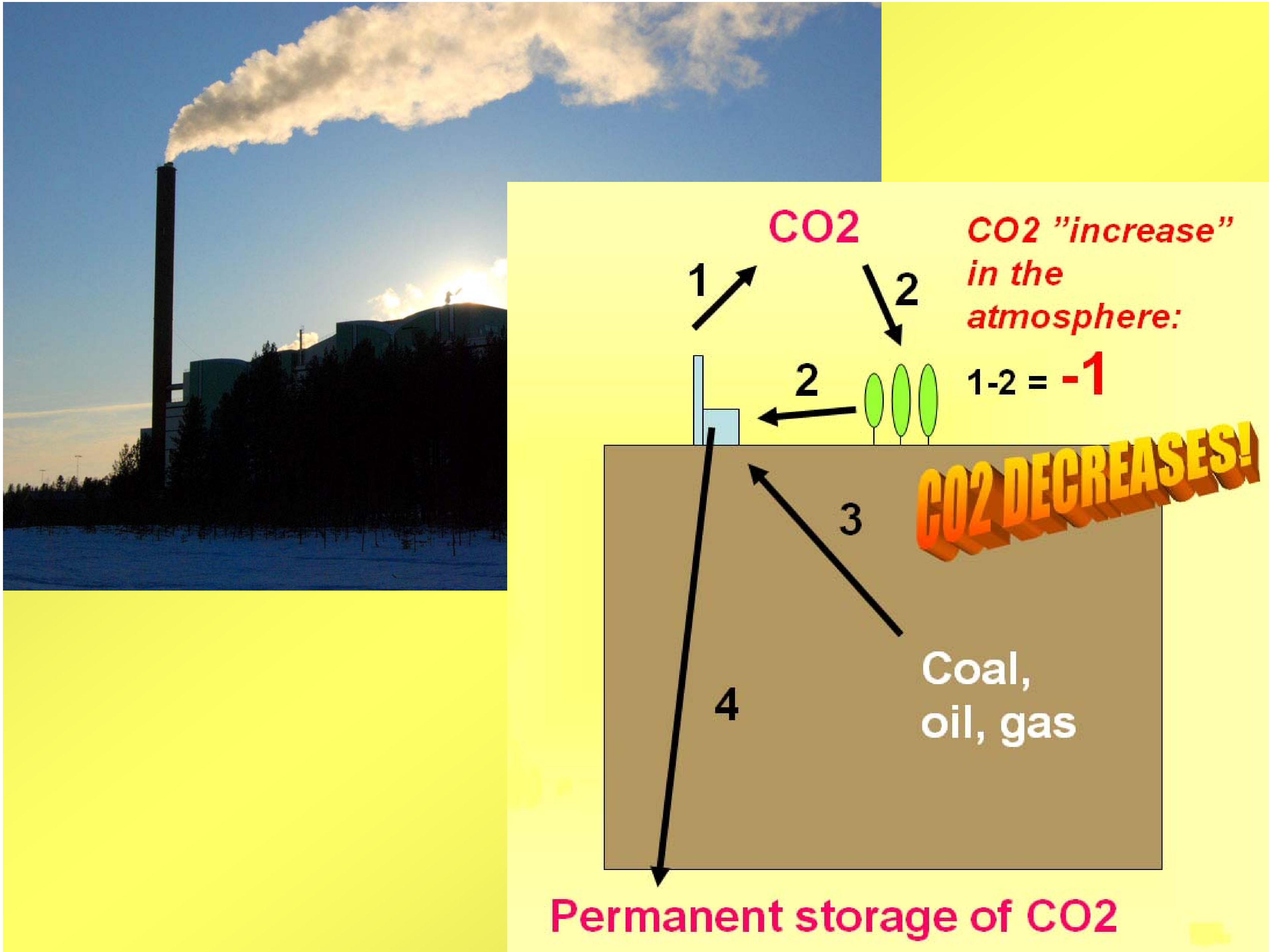
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- The system optimization models defined in this paper make it apparent that new mathematical functions with empirical support are needed in several cases.
- For instance, it is important to determine parameters of mathematical functions that describe how the value of recreation is affected by the properties of the forest stands.
- Let our research move in this direction!

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