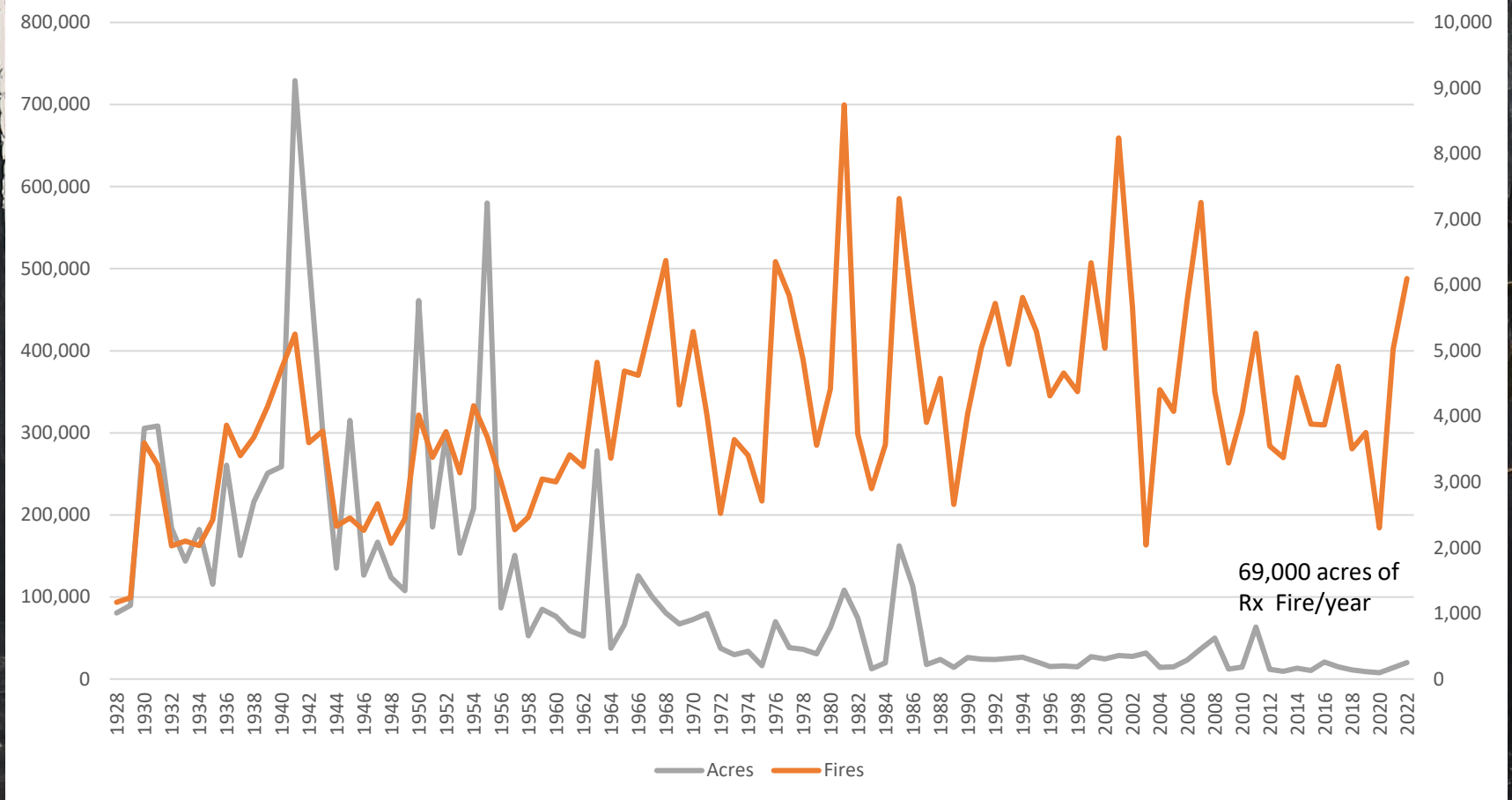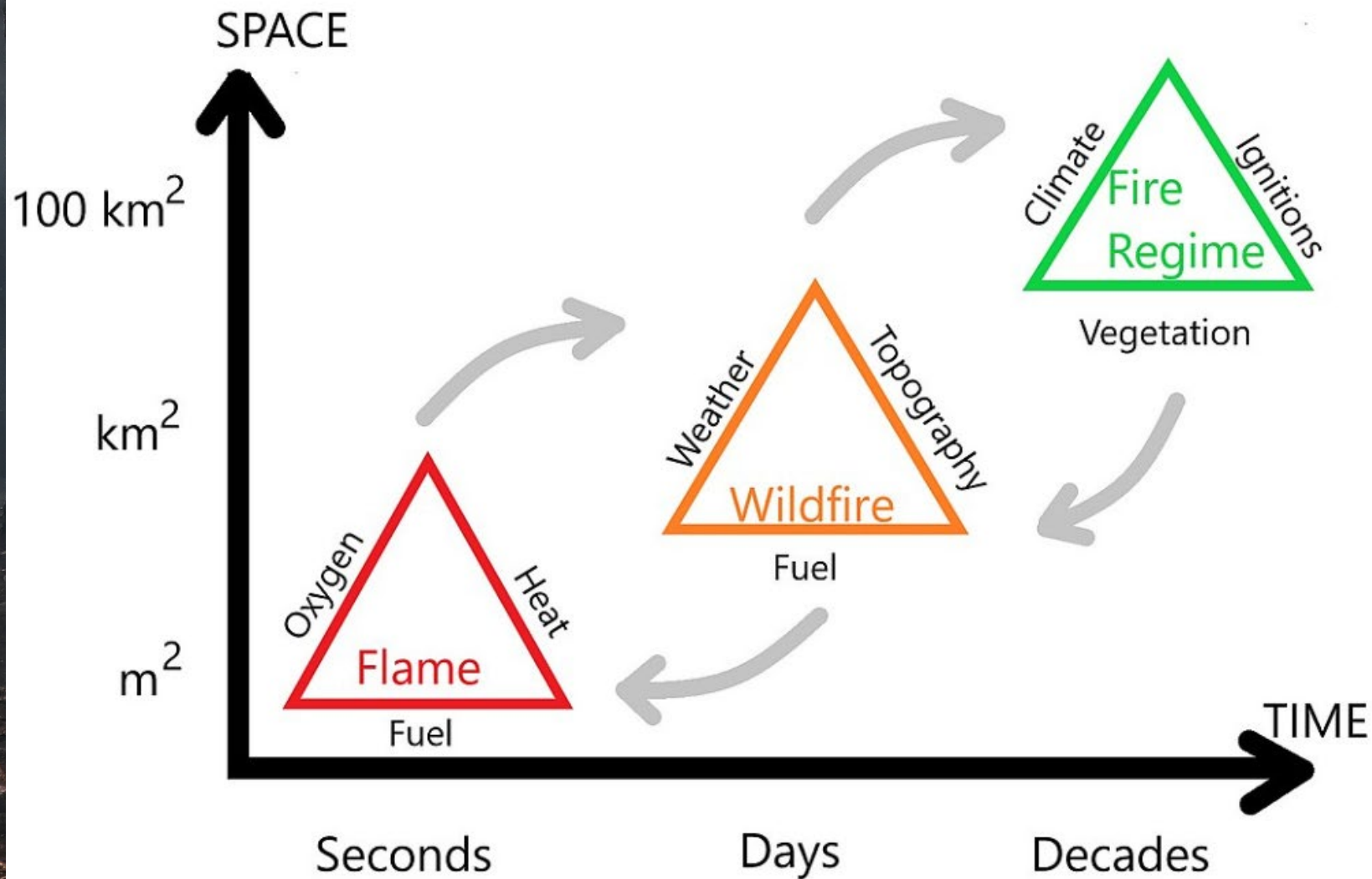Dr. Joseph Roise

Professor of Forestry and Operations Research

Southern Fire Exchange

Department of Forestry and Environmental Resources

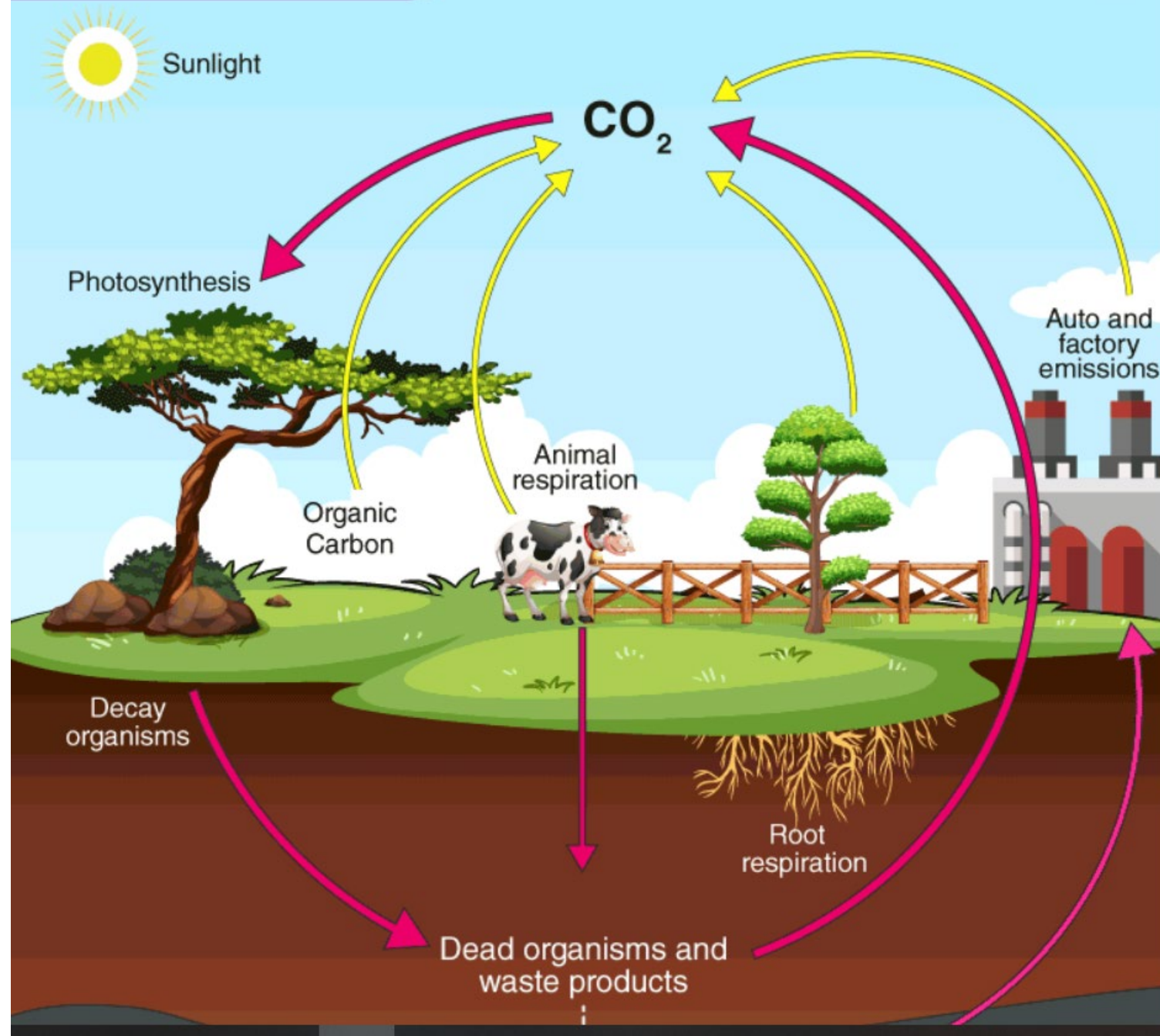North Carolina State University

North Carolina WildFire History
Fires on the right and **acres** of fires on the left

69,000 acres of
Rx Fire/year

Acres   Fires

Earth the Fire Planet
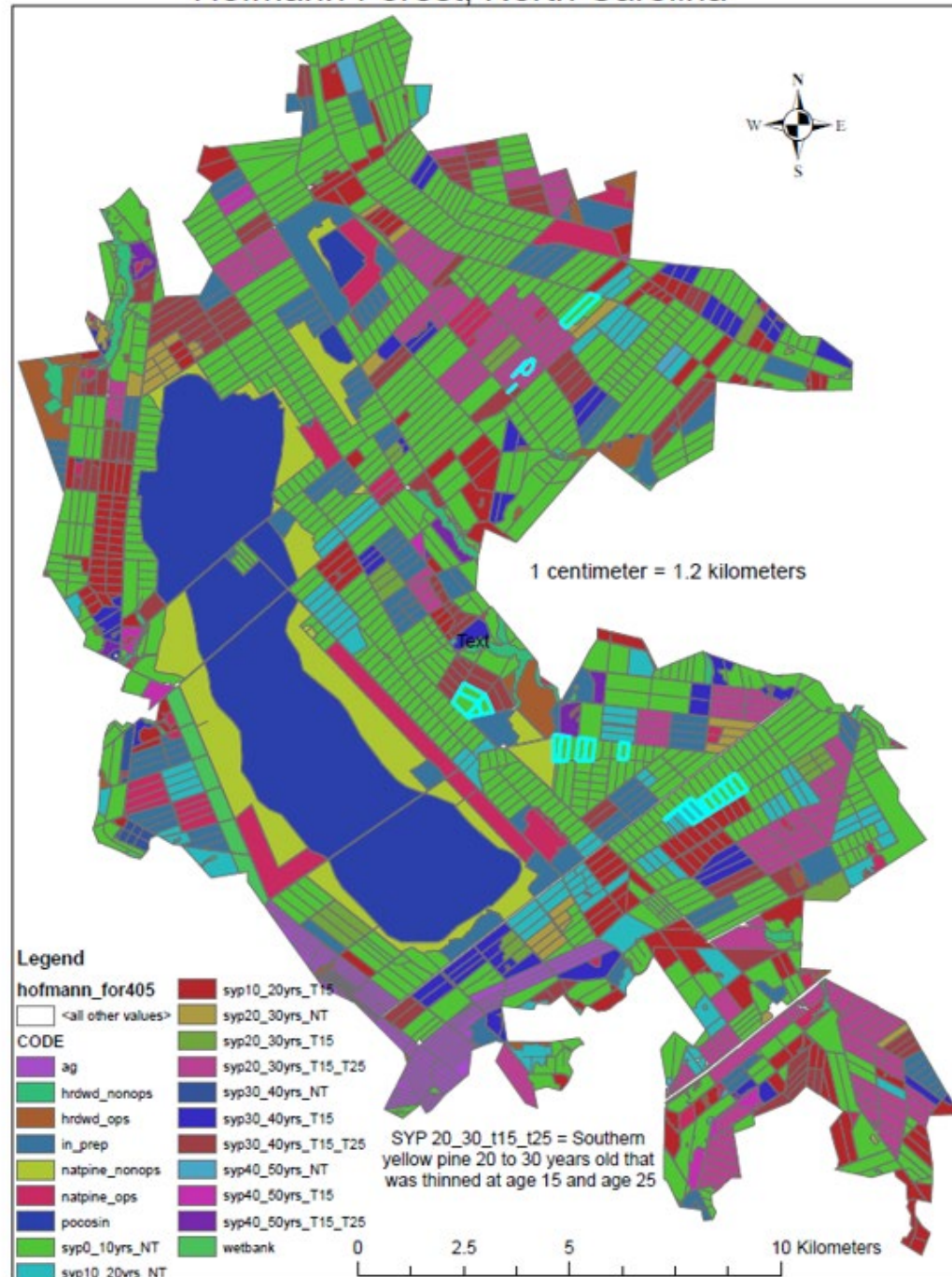
Hofmann Forest, North Carolina

Physical land base for the Hofmann Forest

123.5 sq. miles
~36,000,000 trees

Mathematical Program for Hofmann Forest

Print the matrix onto 8 ½ and 11 inch paper. With font size 11, .1 inch margins. Lay the pages out on a flat surface will cover

122.8 sq. miles

Management Science or Operation Research or Systems Analysis or Mathematical Programming or Data Science

Remarkably accurate for management decision making.

Management Science gives us the ability to integrate information from all "relevant" sources for decision making purposes.

1 centimeter = 1.2 kilometers

SYP 20_30_t15_t25 = Southern yellow pine 20 to 30 years old that was thinned at age 15 and age 25

Legend

hofmann_for405

<all other values>

CODE

ag
hrdwd_nonops
hrdwd_ops
in_prep
natpine_nonops
natpine_ops
pocosin
syp0_10yrs_NT
syp10_20yrs_NT

syp10_20yrs_T15
syp20_30yrs_NT
syp20_30yrs_T15
syp20_30yrs_T15_T25
syp30_40yrs_NT
syp30_40yrs_T15
syp30_40yrs_T15_T25
syp40_50yrs_NT
syp40_50yrs_T15
syp40_50yrs_T15_T25
wetbank

0   2.5   5   10 Kilometers

Hofmann Forest Multi Objective Mathematical Programming Results: NPV vs Carbon Tonnes
Time horizon was 100 years.
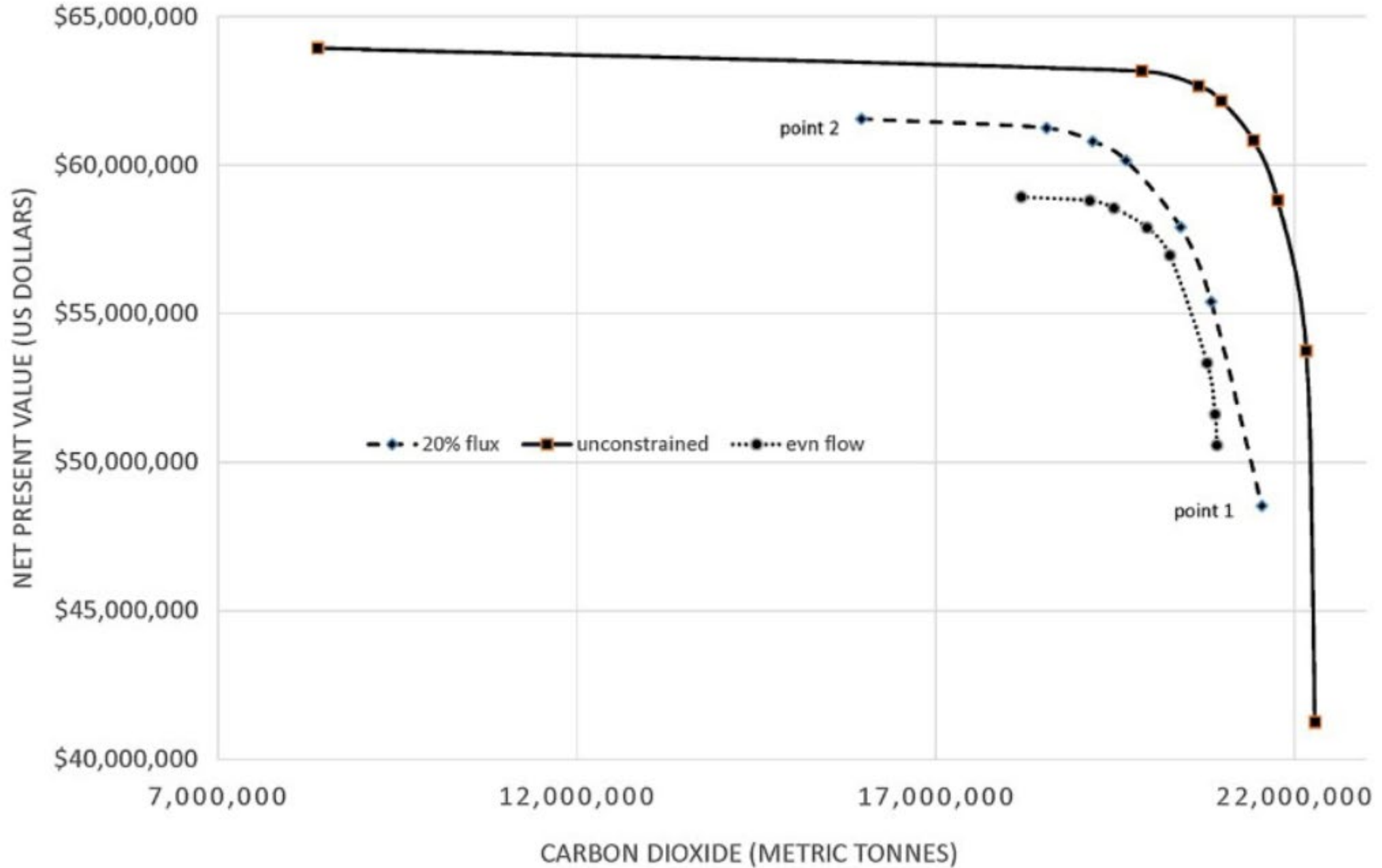
Annual Global emissions of carbon dioxide in 2022 37.12 billion metric tons

Oceans absorb about 31% of the CO_2 emissions released into the atmosphere according to a study published by NOAA and international partners in *Science (2007)*.

Leaving 25.61 billions of tonnes   (a tonne = a metric ton)

Forests absorb about 30% of the CO_2 emissions released into the atmosphere.

Leaving 17.93 billion tonnes of CO_2 emissions

The opportunity cost per ton in, NPV US dollars, associated with increases in carbon production for the three different harvest flow constraints.

$\dfrac{20,000,000 \text{tonnes}}{79,000 \text{ acres}}$ = 253 tonnes/acre

Over a 100 year period = 2.53 tonnes/acre

In the USA 514.2 million acres of timberland net sequestration of 1.302 billion tonnes/year

17.93 billion tonnes annual net global emissions of carbon dioxide 2022

9.880 billion acre of timberland on earth using the Hofmann as example. 24.996 billions tonnes/year,

Figure legend: – ◆ – 20% flux   ▬■▬ Unconstrained   ●···· even flow

Point 1

20,000,000 tonnes at $1/tonne

Forest could absorb 24.995 Billion tonnes/year > 17.93 billion tonnes/year

Mass Timber

It is possible but is it probable?

What are the hurdles?

Too many humans on needing wood products to survive
 (this is what created the profession of forestry in the 1300's.)

Most landowner will need the $1/tonne to change their practices
 The conversion of forests into housing developments or other man-made objects

Carbon Credit Markets for better forest carbon management, a good idea but not currently sufficient to solve our problem.
 You would need for 72% of the timberland on earth to be under new management.
 The new management would have to be comprehensive long term forest management.

Forest grow at a predictable rate in tonnes/year. Take several decades to reverse current trends.

Estimated global population from 10,000BCE to 2100

(in millions)
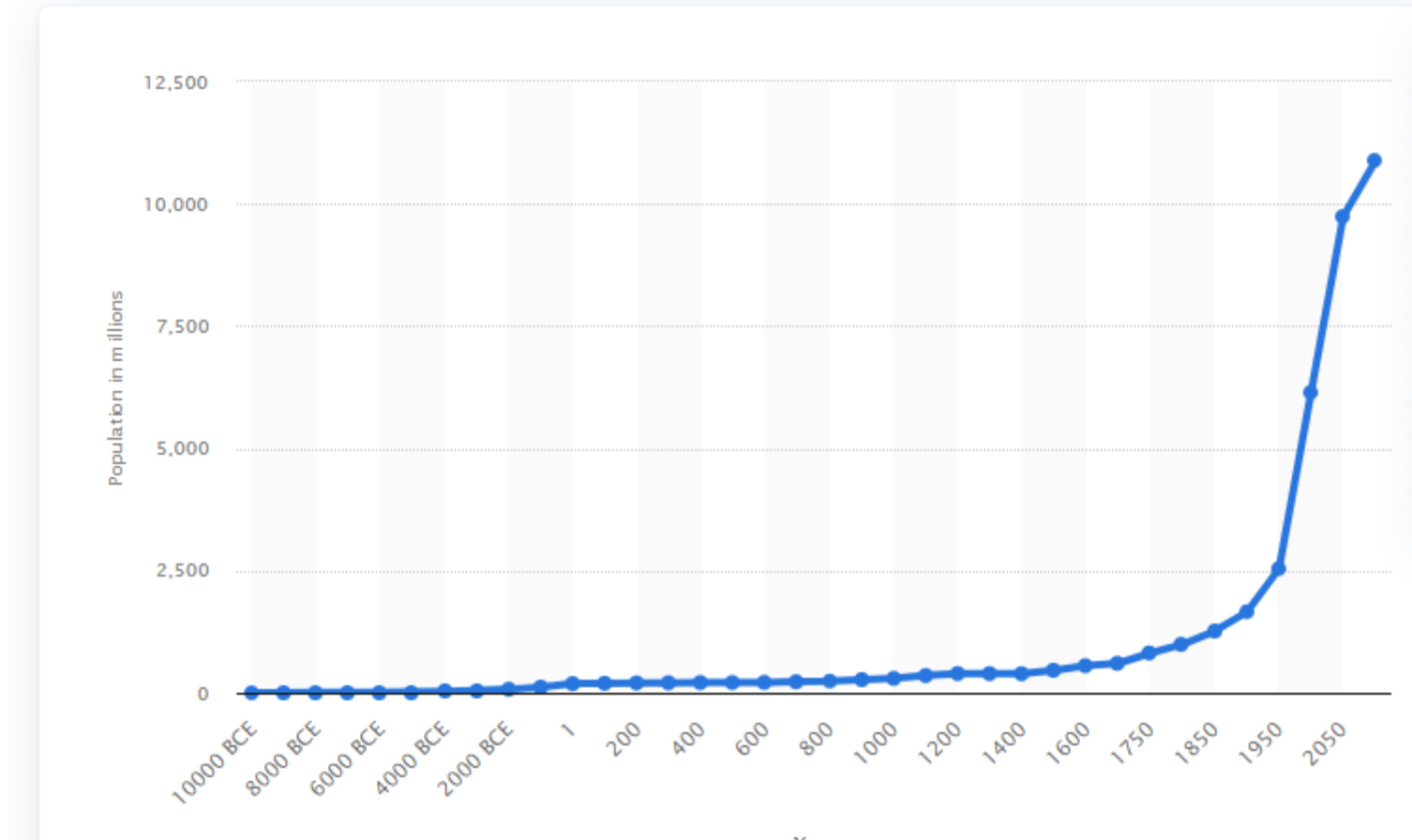
Climate is what you expect while weather is what you get

Change in surface temperature from present (°C)

-12   -10   -8   -6   -4   -2   0   2   4   6

21,000 years ago   6,000 years ago   2071–2095 (RCP8.5)

Weather

Changes in Solar Inputs

Changes in the Atmosphere: Composition, Circulation

Changes in the Hydrological Cycle

Clouds

Atmosphere

N_2, O_2, Ar,
H_2O, CO_2, CH_4, N_2O, O_3, etc.
Aerosols

Volcanic Activity

Atmosphere-Biosphere Interaction

Atmosphere-Ice Interaction

Precipitation Evaporation

Terrestrial Radiation

Human Influences

Ice Sheet

Heat Exchange

Wind Stress

Glacier

Biosphere

Land-Atmosphere Interaction

Sea Ice

Soil-Biosphere Interaction

Land Surface

Hydrosphere: Ocean

Ice-Ocean Coupling

Hydrosphere: Rivers & Lakes

Changes in the Cryosphere: Snow, Frozen Ground, Sea Ice, Ice Sheets, Glaciers

Changes in the Ocean: Circulation, Sea Level, Biogeochemistry

Changes in/on the Land Surface: Orography, Land Use, Vegetation, Ecosystems

Cell Respiration Formula

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + ATP$$

Glucose   Oxygen   Carbon Water Energy
Dioxide

Fuel   + Oxygen +   Heat   →   Carbon dioxide + Water + Heat&Light

solar
energy

$$6CO_2 + 6H_2O \xrightarrow{\text{Photosynthesis}} C_6H_{12}O_6 + 6O_2$$

carbon   water   glucose   oxygen
dioxide