Biophysical processes in the Adriatic sea
Croatian Academy of Sciences and Arts
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Towards analysis ready primary production data

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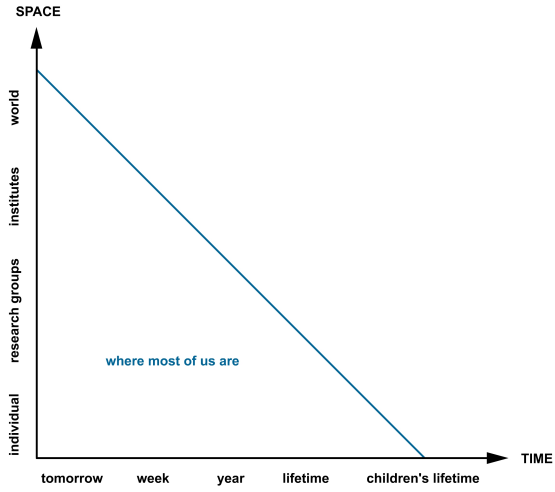
What are analysis ready data?

Analysis ready data are data that have been processed to a minimum set of requirements and organized into a form that allows immediate analysis with a minimum of additional user effort...

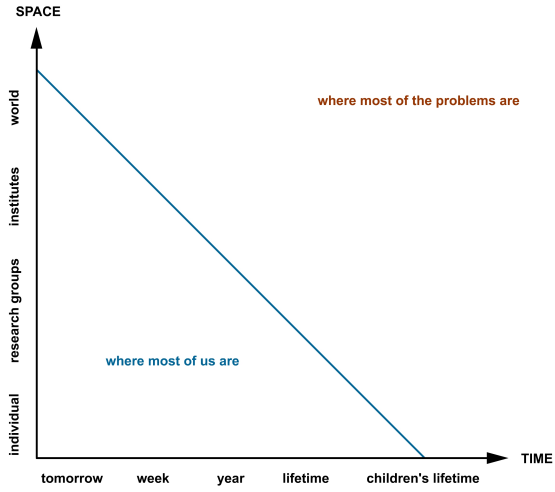
Adopted from the Commity of Earth Observation Satellites

Motivation



Adopted from Limits to growth (1972)

Motivation



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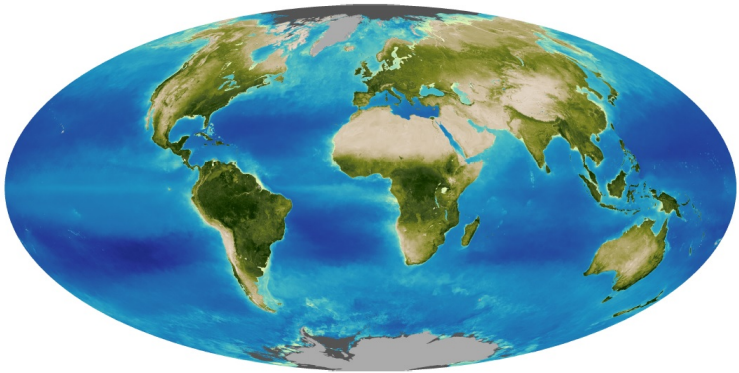
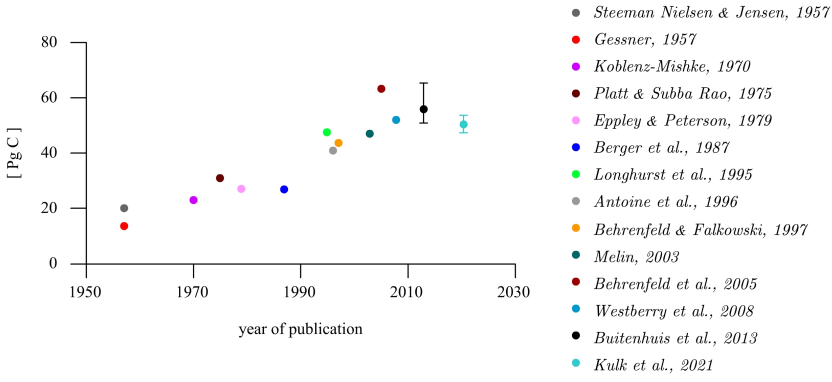
Where we are now



Anthropogenic carbon emissions per year 10 Gt C
Carbon assimilated by the biosphere per year 100 Gt C
Carbon assimilated by phytoplankton 50% of total
Phytoplankton biomass 1% of total land biomass

How we got here

Global annual marine primary production from the literature



Adopted from Buitenhuis et al. (2013)

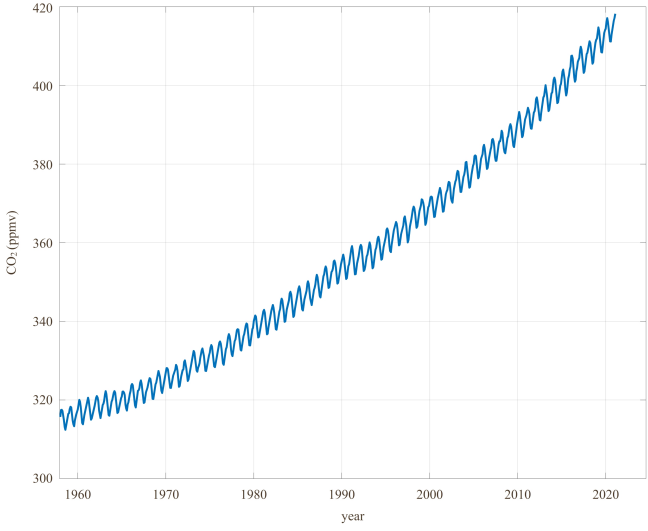
Where are we going?

Tragedy of the commons

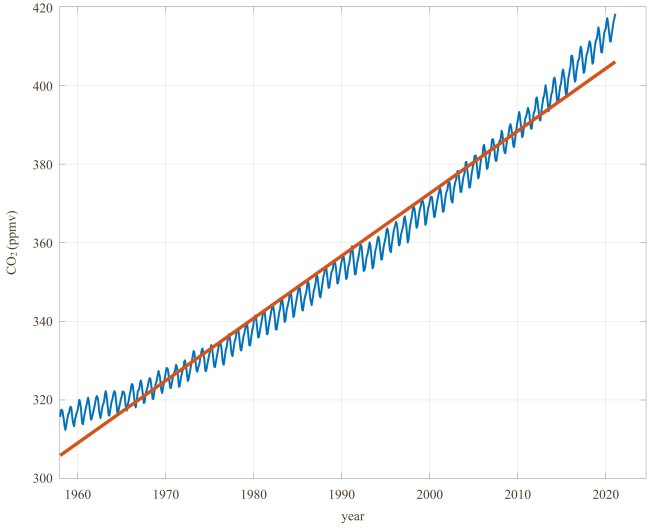
If decisions about the use of renewable natural resources are based exclusively on profits, even long-term profits, **renewable natural resources will be used on a sustainable basis only if their biological growth rate is greater than the expected growth rate of alternative investments.** Because the growth rate of the world economy today is greater than the biological growth rate of most renewable resources, there are powerful economic incentives not to use renewable natural resources on a sustainable basis. **If people accept the rules of the game in a free market economy, it is rational to use renewable resources unsustainably whenever biological production fails to compete with alternative forms of investment.**

(Marnet, 2001)

The Keeling curve

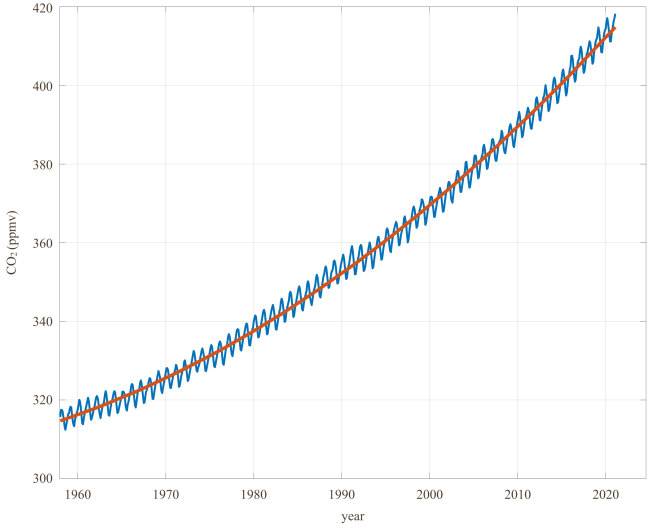


The Keeling curve



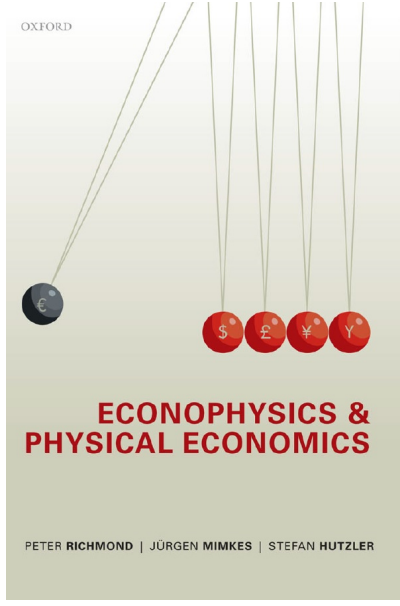
The trend is not linear!

The Keeling curve

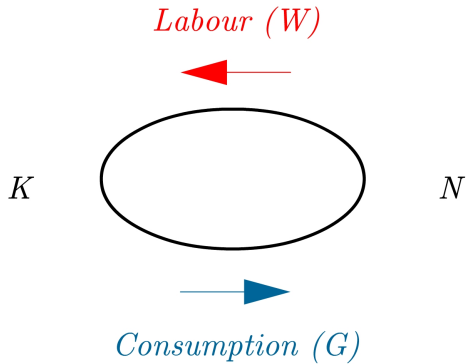


The trend is not linear!

The source of the problem?



A model of a closed natural production circuit



Labourers from N households work in the fields (their capital, K). In return for their work, W, consumer goods, G, are brought back from the fields to the households.

Critique: A far too simple description for modern day economy!

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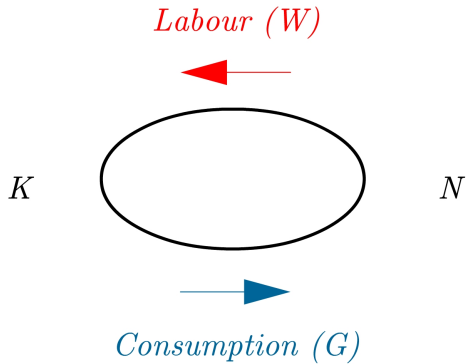
Is it really?!

A model of a closed natural production circuit



Ships from N **harbours** fish on the **sea** (their capital, K). In return for their **effort**, W, **fish**, G, are brought back from the **sea to the harbour**.

The broader picture

Going back to 1931!

Contemplation of the world's disappearing supplies of minerals, forests, and other exhaustible assets has led to demands for regulation of their exploitation. The feeling that ***these products are now too cheap for the good of future generations****, that they are being* ***selfishly exploited at too rapid a rate****, and that in consequence of their excessive cheapness they are being produced and consumed wastefully has given rise to the conservation movement.*

(Hotelling, 1931)

Valuation: a hard problem

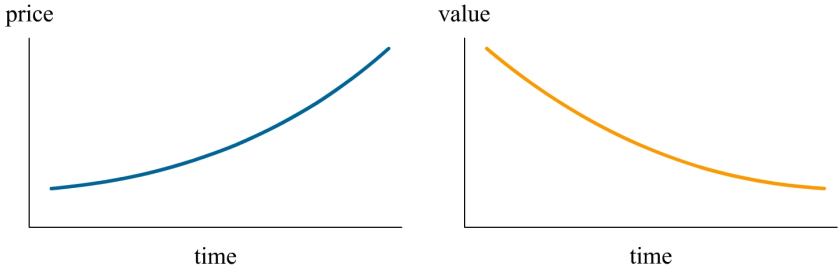
What would you rather: a tree today or two trees tomorrow?

Valuation: a hard problem

What would you rather: a tree today or two trees tomorrow?

Depends on how fast the trees grow!

Discounting



The process of converting value received in the future to value received now.

Well, how “fast” is primary production in the sea?

Approaches to studying primary production

In situ

Incubation at sea under natural light conditions.
(Steemann Nielsen, 1952)

In vitro

Incubation under controlled light conditions.
(Platt i Jassby, 1976)

In silico

Computer implementation of primary production models.
(Gentleman, 2002)

In situ time series of primary production

Stončica	1962	
Kaštelanski zaljev	1962	
Bermuda Atlantic Time Series	1988	bats.bios.edu
Hawaii Ocean Time Series	1988	hahana.soest.hawaii.edu/hot/hot-dogs
Cariaco	1996	imars.marine.usf.edu/car
Monterey Bay	1988	www.mbari.org/bog
La Coruña	1990	www.seriestemporales-ieo.com
Western Channel Observatory	1992	www.westernchannelobservatory.org.uk

+ 1148 annual time series from 483 locations (Cloern et al., 2014)
+ 125 time series longer than 8 years with more than 10 measurements per year (Winder & Cloern, 2010)

An example from the Arctic

Phytoplankton Productivity in the Eastern Canadian Arctic during July and August 1980

B. Irwin, L. Harris, P. Dickie, P. Lindley, and T. Platt

Marine Ecology Laboratory
Ocean Science and Surveys, Atlantic
Department of Fisheries and Oceans

Bedford Institute of Oceanography
P.O. Box 1006
Dartmouth, Nova Scotia B2Y 4A2

March 1983

Canadian Data Report of Fisheries and Aquatic Sciences No. 386

An example from the Arctic

EASTERN ARCTIC 1980

LAT 50 42.80'N LONG 57 44.60'W DATE 16 07 80 DEPTH 8M

I	P	I	P	I	P	I	P
825.1	2.28	803.9	1.50	719.3	1.23	698.2	1.90
668.5	1.89	575.5	3.97	571.2	3.02	524.7	3.08
461.2	3.81	431.6	4.40	359.7	4.73	359.7	3.47
304.7	4.37	220.0	4.74	213.7	4.17	211.6	4.19
148.1	4.76	129.1	4.35	99.4	4.16	98.2	4.42
67.7	3.95	61.4	4.21	46.5	4.40	44.4	3.71
36.4	4.29	31.7	3.35	27.1	3.57	18.2	2.53
15.7	2.57	12.1	1.83	12.1	1.69	9.1	1.48
9.0	2.23	6.5	1.06	6.3	1.23	4.3	.85
3.9	.71	2.9	.60	2.7	.56	2.2	.48
2.0	.53	1.6	.46	1.5	.39		

PARAMETER VALUES

PS : 5.42 ALPHA : .198 BETA : .0060

(5.12, 5.72) (.180, .216) (.0049, .0070)

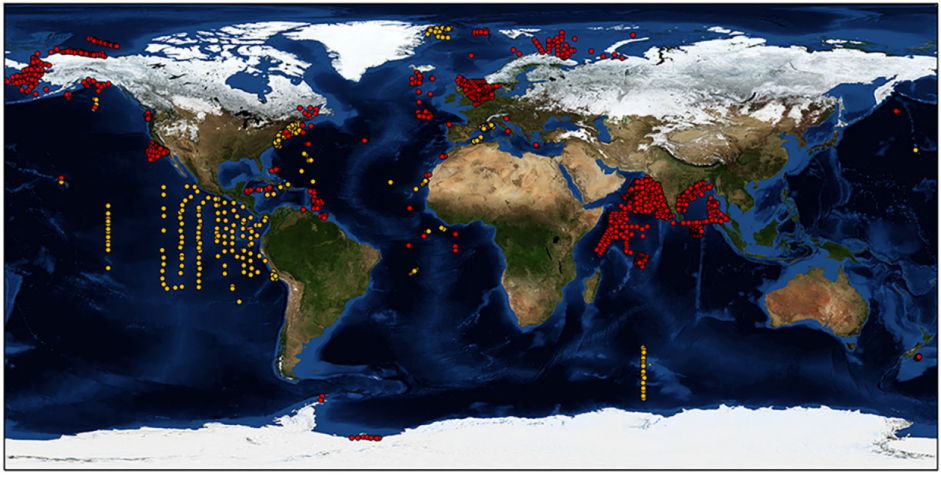
SAMPLE TEMPERATURE 10.5 C INCUBATION TEMPERATURE 5.5 C

Such data come in the form of reports, which have to be digitized **by hand!**

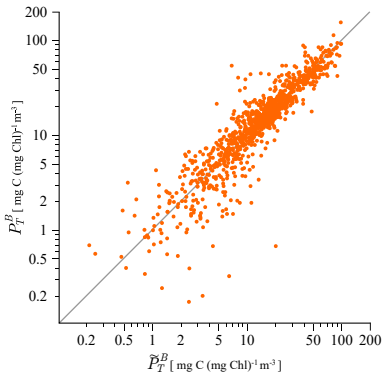
Thus far **we have digitized some 20%** of the entire dataset.

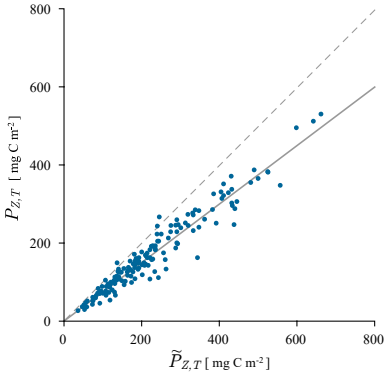
We estimate the entire dataset to have around **50 000 incubations**, which ammounts to around **100 000 datapoints** which have to be typed in.

Global dataset from Mattei & Scardi (2021)



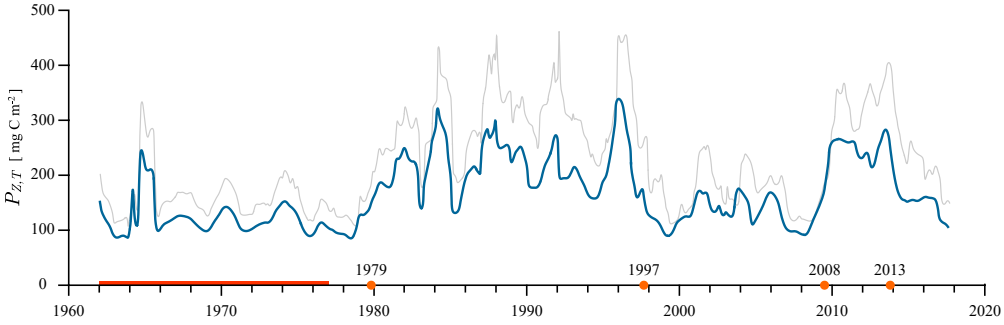
Measured versus modelled production at the Stončica station





Kovač et al. (2018)

An example from the Adriatic



Kovač et al. (2018)

A society grows great when elders plant trees
in whose shade they know they shall never sit.

PHOTOCLIM

PHOTOCLIM.ORG

HrZZ

Croatian Science Foundation

Thank you!