

F9. SOK-2011: Bærekraftig utvikling

Naturressurser

Naturressurser



«Gaver fra naturen»

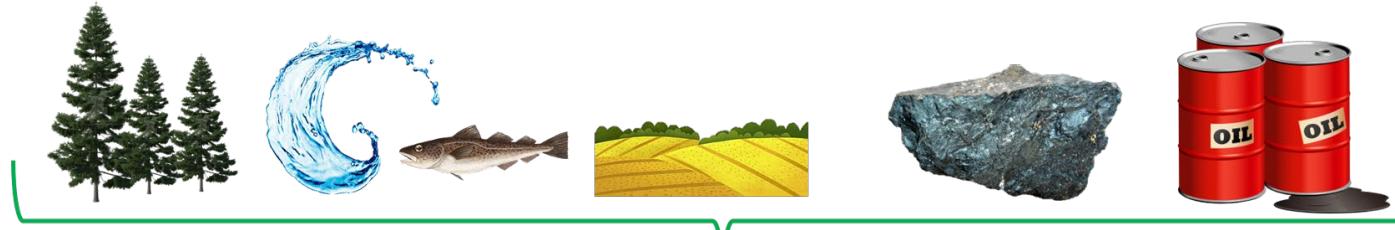
Vi trenger ikke å produsere dem

Råmaterial til livsviktige
goder og tjenester

Absorberer avfall fra
mennesker og dyr

Gir nytte fra rekreasjon

Naturressurser



«Gaver fra naturen»

Vi trenger ikke å produsere dem

Råmaterial til livsviktige
goder og tjenester

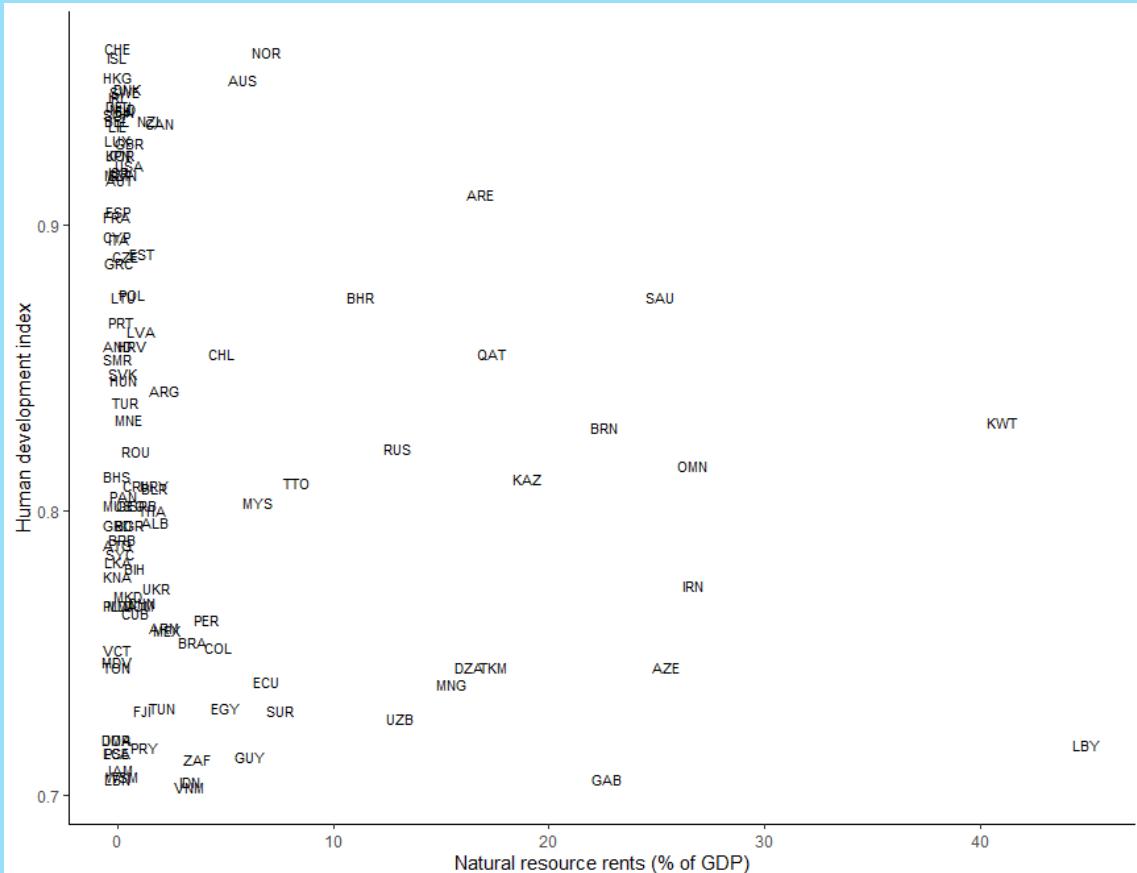
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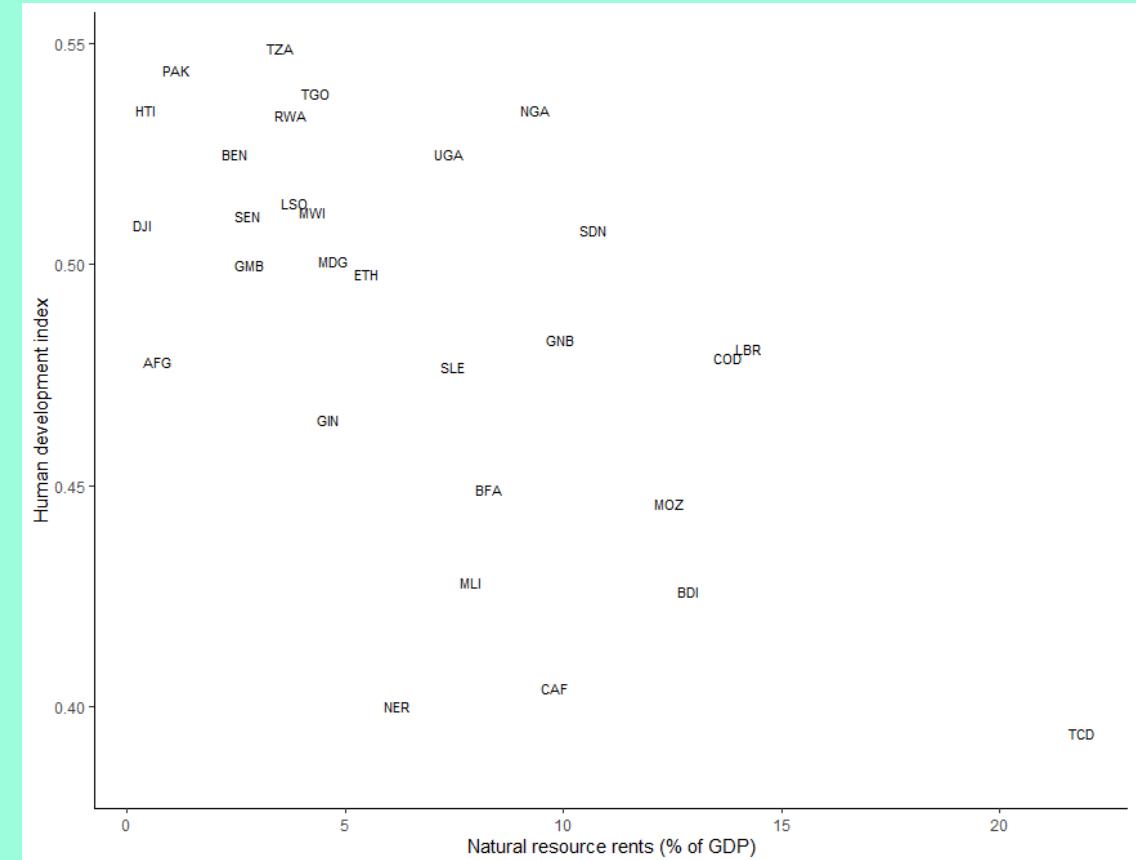
«Primær produksjonsfaktor» = Svært attraktiv inntektskilde

Menneskelig utvikling (HDI) og vekten av naturressurser i BNP

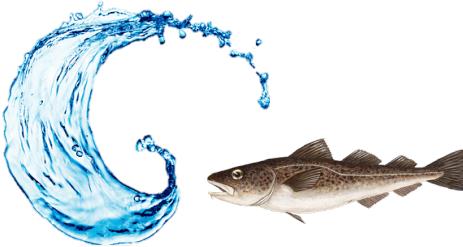
Høyt eller svært høyt nivå på utvikling (HDI = 0.7 - 1)



Lavt nivå på utvikling (HDI = 0.4 – 0.55)



Naturressurser



Hvordan kan vi forklare at mange naturressurs-rike land har så lavt nivå på menneskelig utvikling?

«Problemet» med naturressurser

1. «Ekstraordinær» profitt



Naturressurser = gaver fra naturen som ikke trenger å bli produsert

Ofte store faste kostnader for å ekstrahere (stordriftsfordeler)

Ekstraksjon krever ofte avansert teknikk

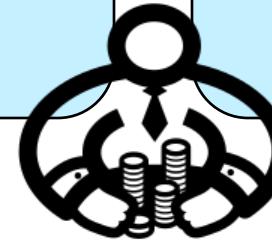
«Problemet» med naturressurser

1. «Ekstraordinær» profitt



Markedsmakt i produksjonen
«Ekstraordinær» profitt

Fattige land:
Avhengighet av finansielt og
humant kapital fra utlandet
(multinasjonale bedrifter)



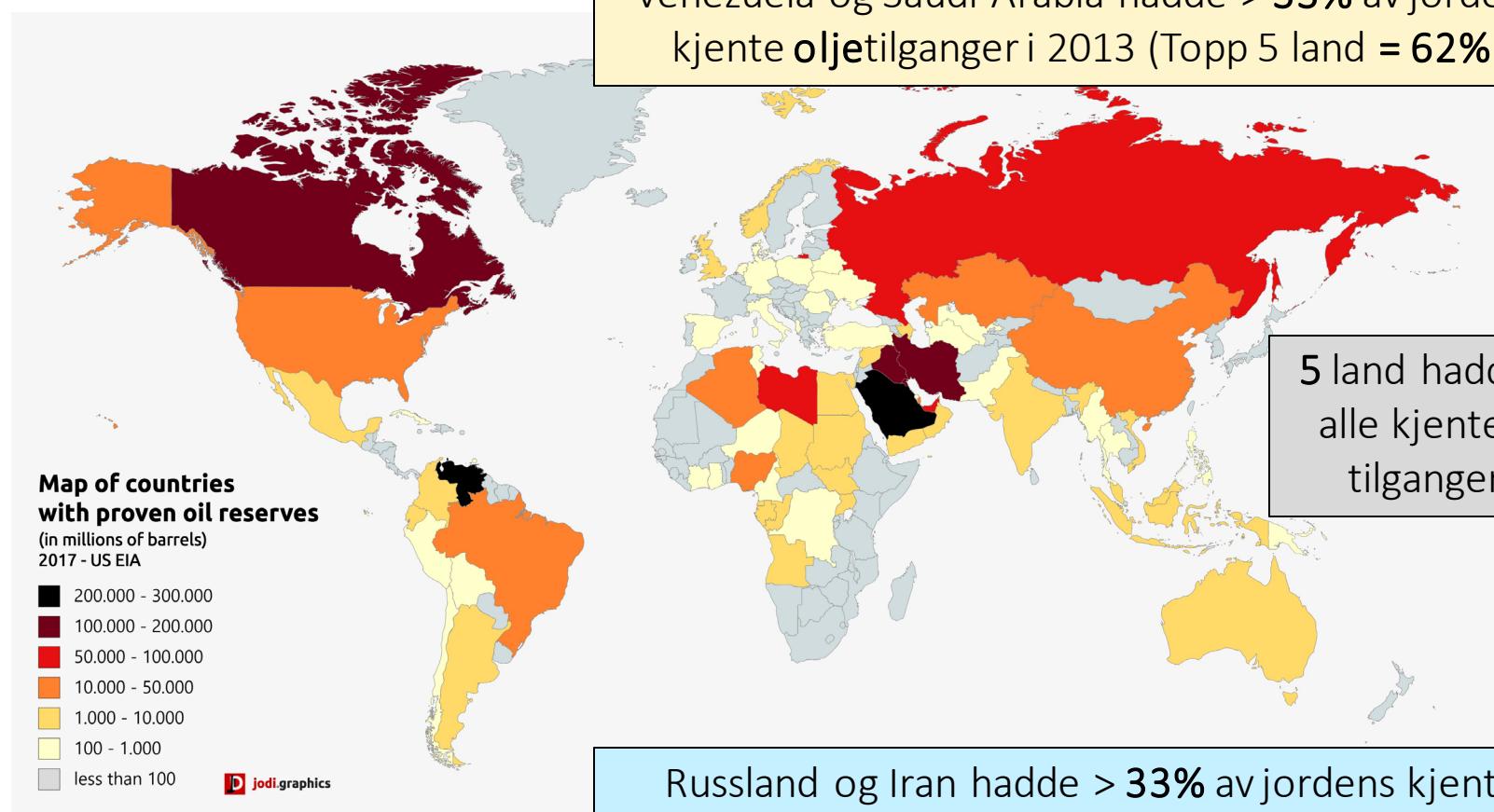
«Problemet» med naturressurser

2. Ujevn fordeling mellom land

Noen land har betydelig mer av en ressurs enn de kan bruke for egen konsum.

Andre land har betydelig mindre enn de trenger av samme ressurs.

Olje



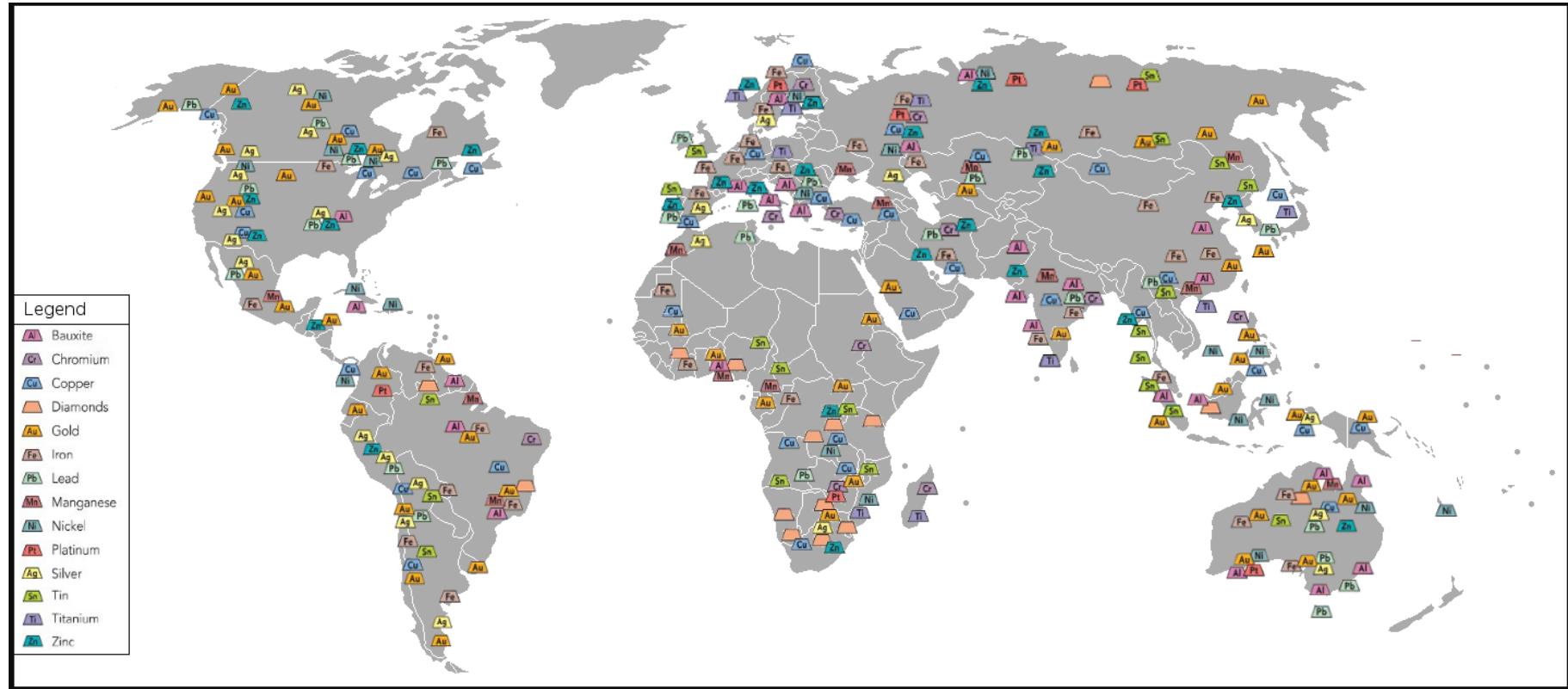
«Problemet» med naturressurser

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Mineraler



https://commons.wikimedia.org/wiki/File:Simplified_world_mining_map_2.png

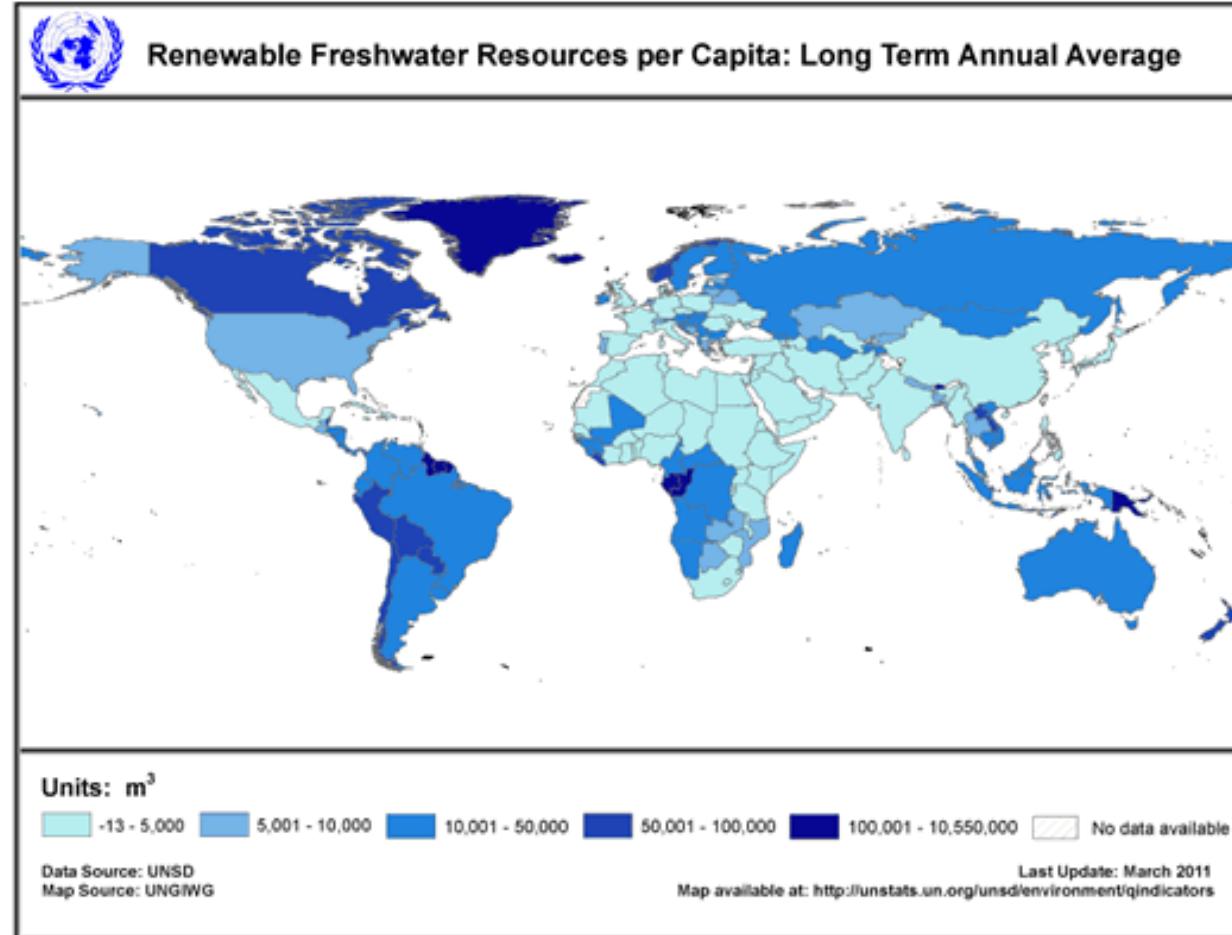
KVDP, Public domain, via Wikimedia Commons

«Problemet» med naturressurser

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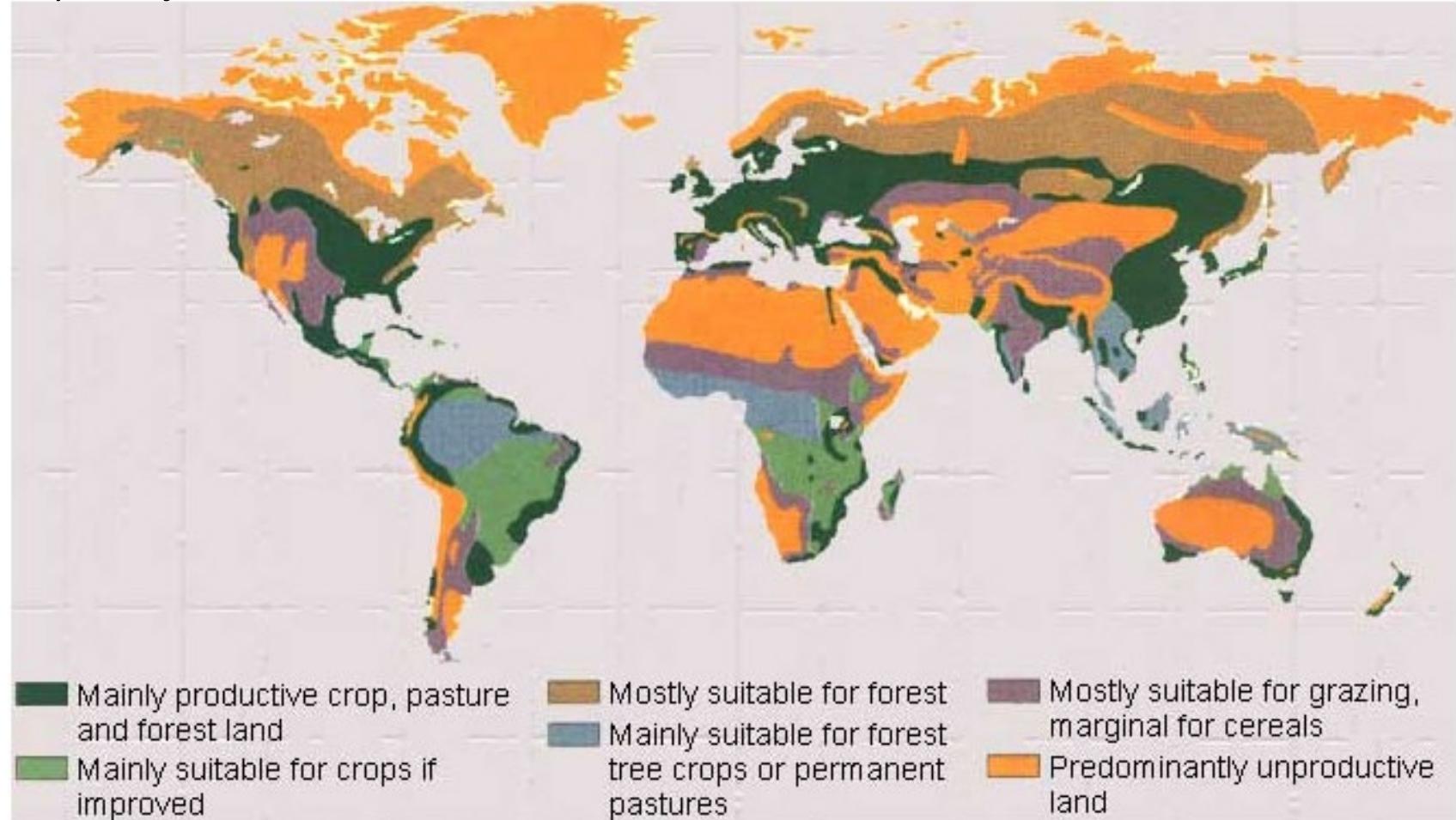
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Dyrkbar jord

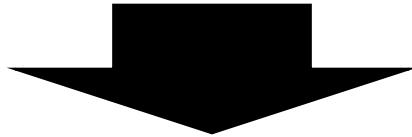


«Problemet» med naturressurser

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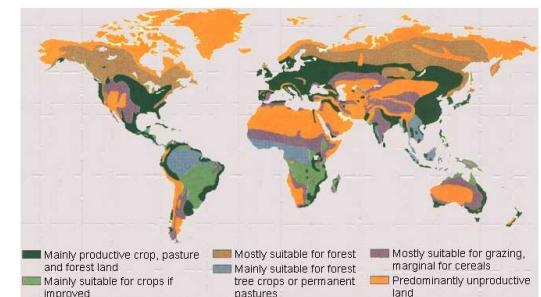
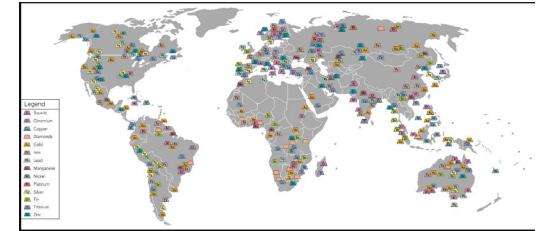
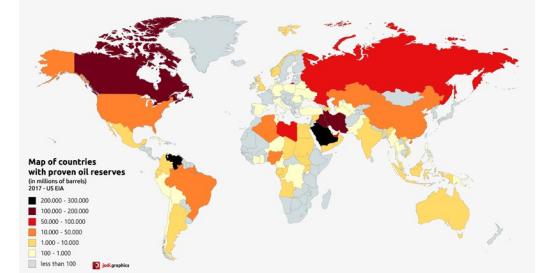
Andre land har betydelig mindre enn de trenger av samme ressurs.



Naturressurser (framfor alt ikke fornybare)

=

eksportgoder



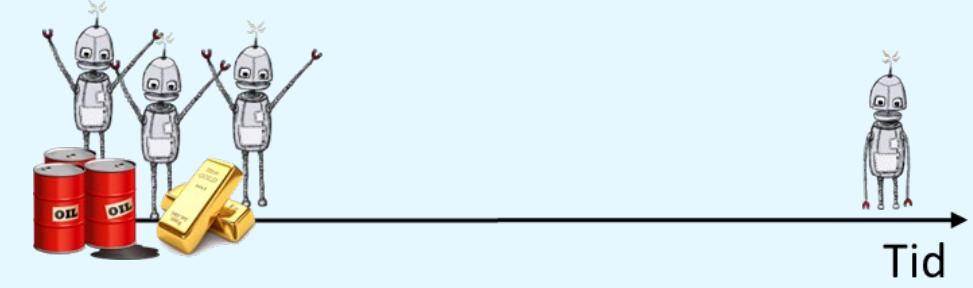
«Problemet» med naturressurser

3. Eksternaliteter

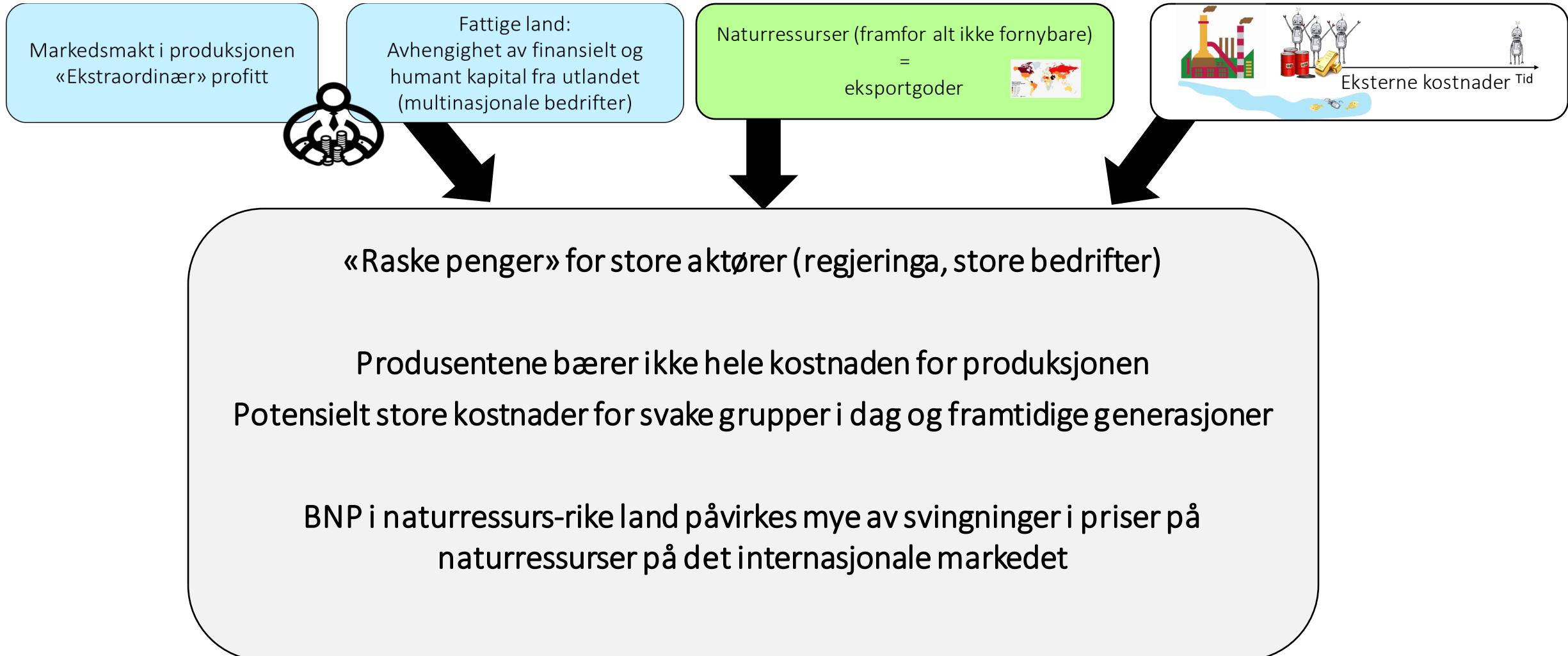
Ekstraksjonen av naturressurser kan føre til forurensning og/eller ødeleggelse av naturen



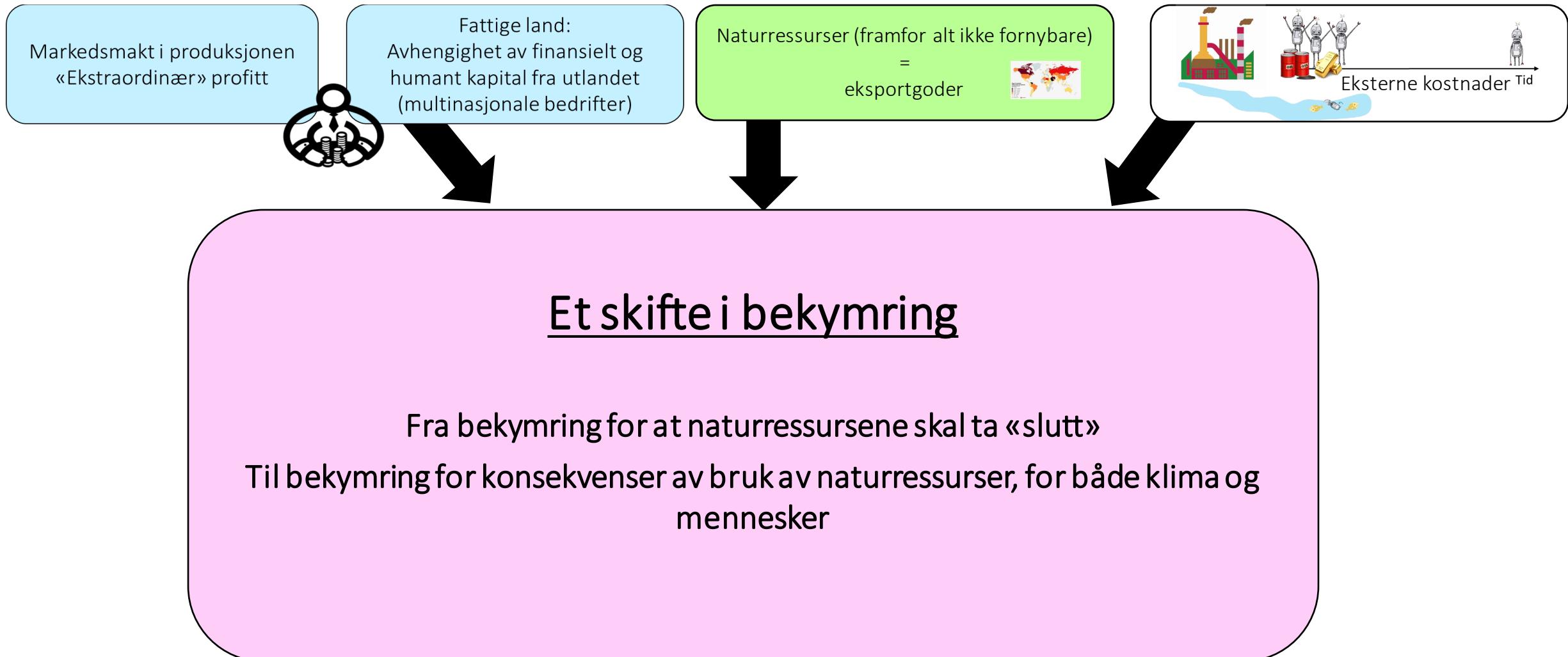
Bruk av ikke fornybare ressurser og et ikke-bærekraftig bruk av fornybare, endelige, naturressurser reduserer tilgangen til ressursene for framtidige generasjoner



«Problemet» med naturressurser



«Problemet» med naturressurser



«Problemet» med naturressurser: «Dutch disease»

En plutselig økning i eksportinntektene (vanligvis som følge av funn av naturressurser) fører til høy inflasjon, økonomisk stagnasjon og økt statsgjeld

Eksempler

- Nederland 1960-tallet (fant naturgass)
- Australia 1850-tallet (fant gull)

«Problemet» med naturressurser: «Dutch disease»

En økonomi med tre produksjonssektorer

Eksport-sektor
(Naturressurser)



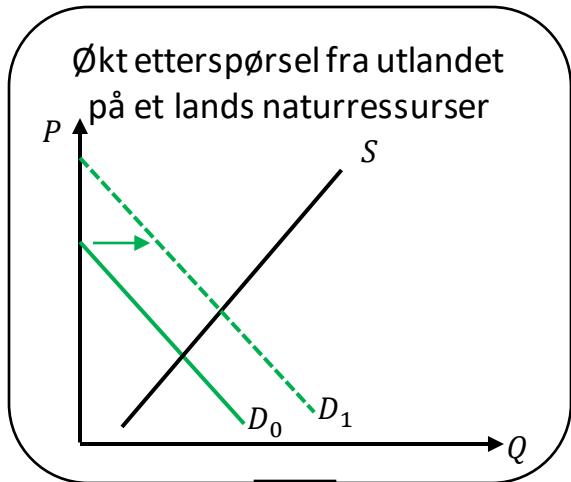
Eksport-sektor
(Andre goder)



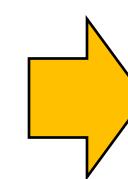
Innenlandskektor
(handler ikke med omverden,
f.eks. frisører, håndverker)



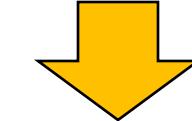
«Problemet» med naturressurser: «Dutch disease»



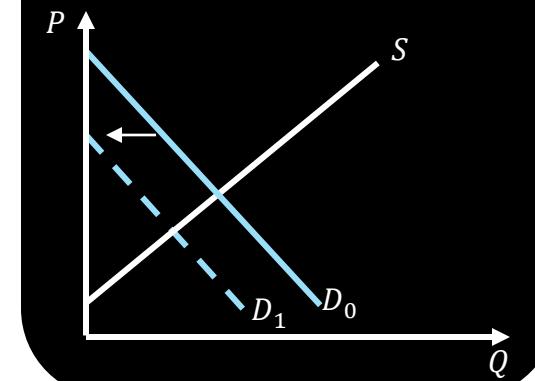
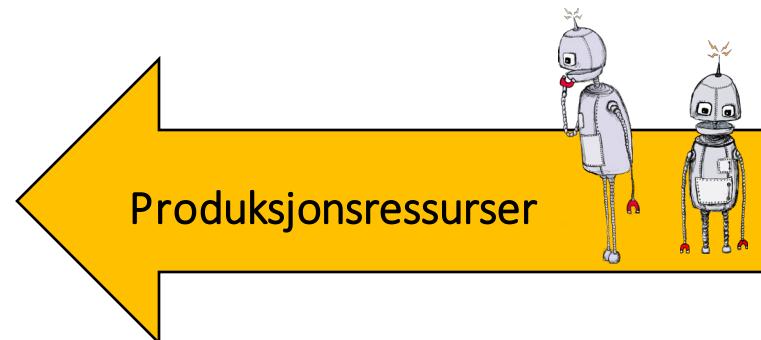
Økt etterspørsel på landets valuta



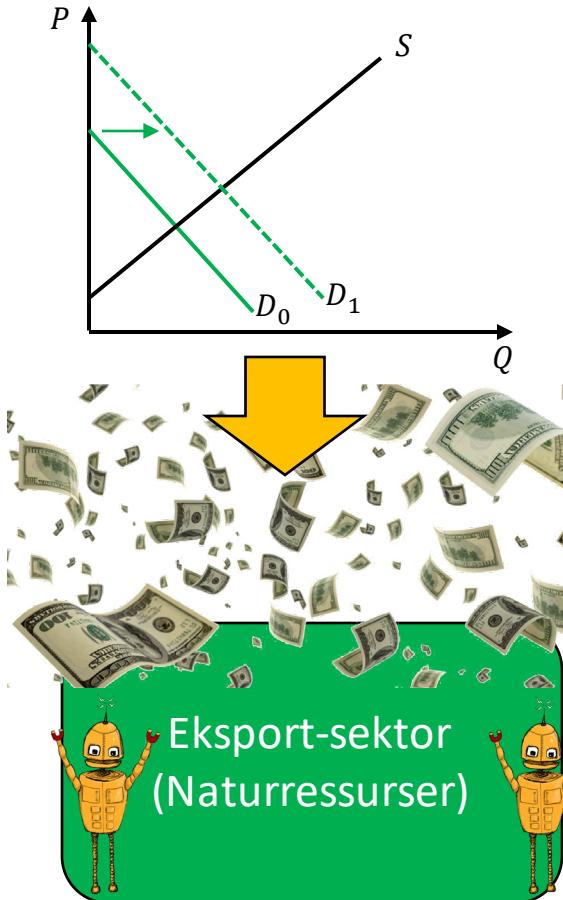
Vekslingskursen appresieres (prisen på valutaen går opp)



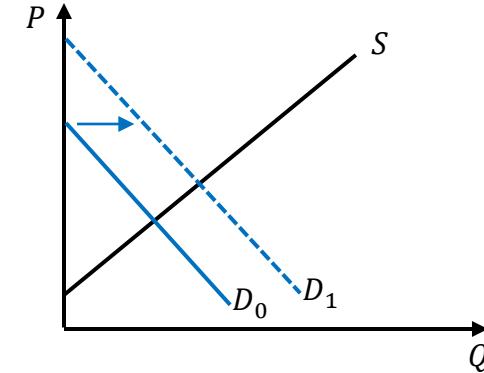
Eksport-sektor
(Andre goder)
Tap i konkurransekraft



«Problemet» med naturressurser: «Dutch disease»



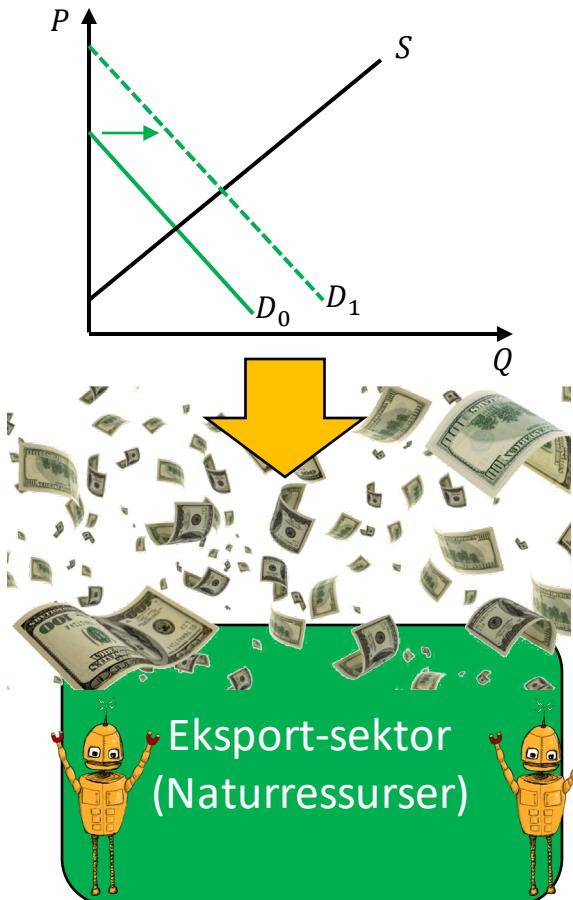
Pris på goder, tjenester og arbeidskraft går opp:
Inflasjonen går opp



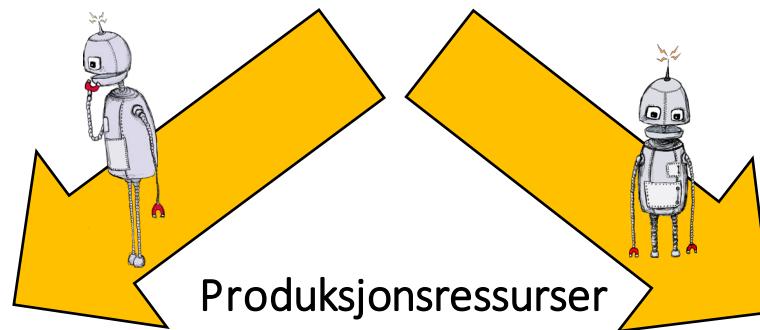
Økt etterspørsel på importerte
og innenlandsk produserte goder

Innenlandsk sektor
(handler ikke med omverden,
f.eks. frisører, håndverker)

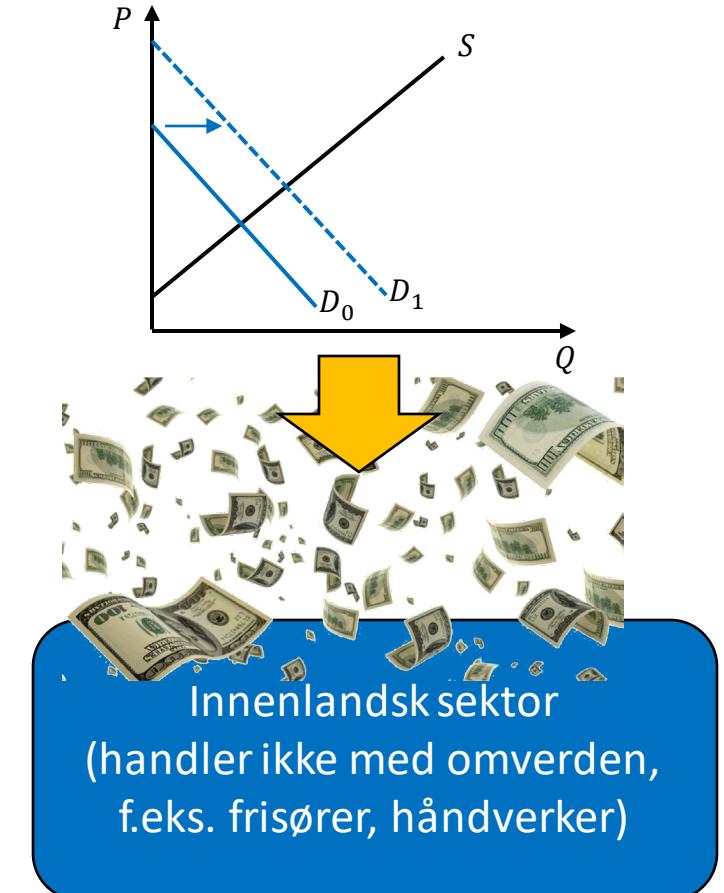
«Problemet» med naturressurser: «Dutch disease»



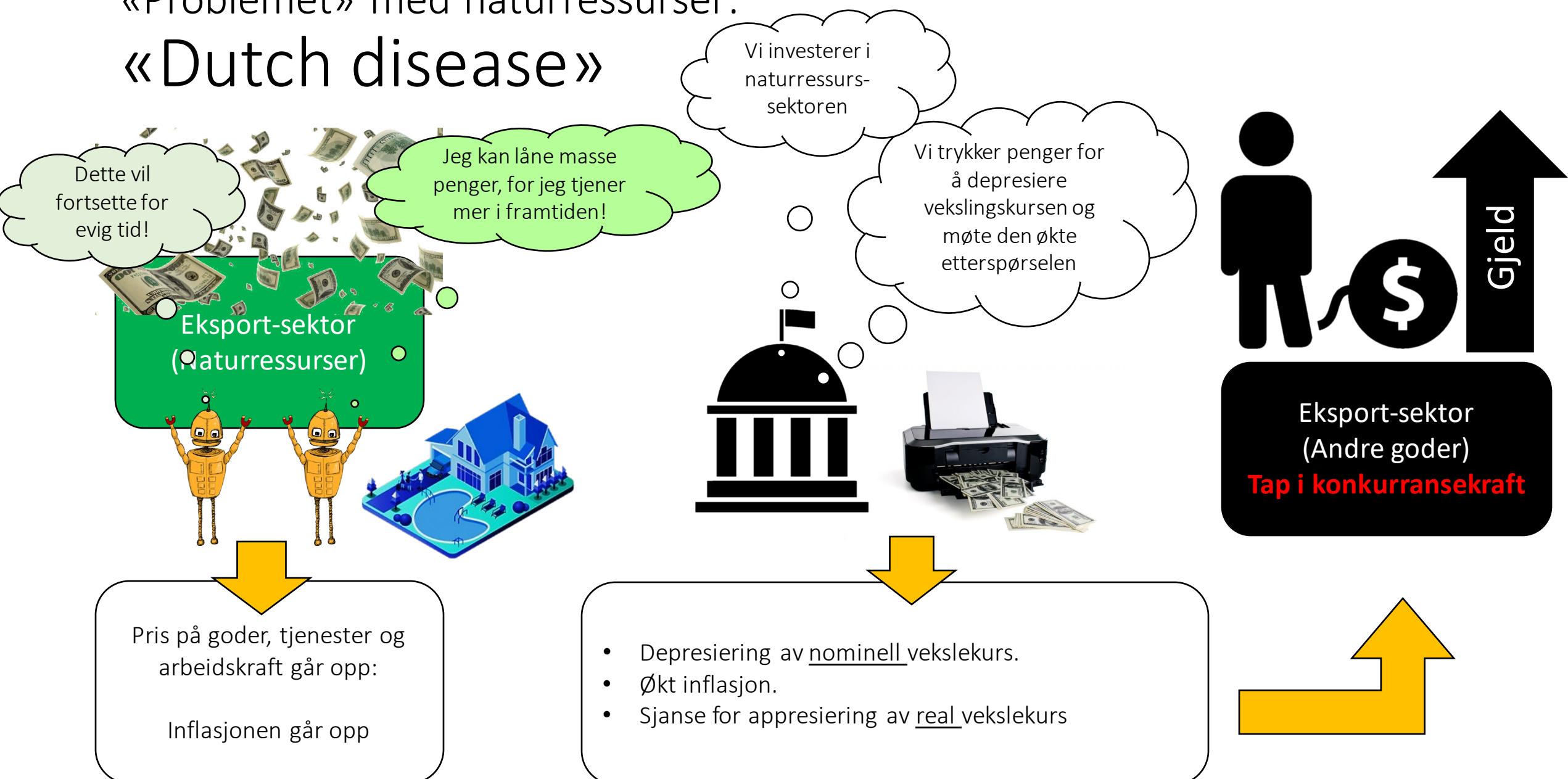
Eksport-sektor
(Andre goder)
Tap i konkurransekraft



Problem?

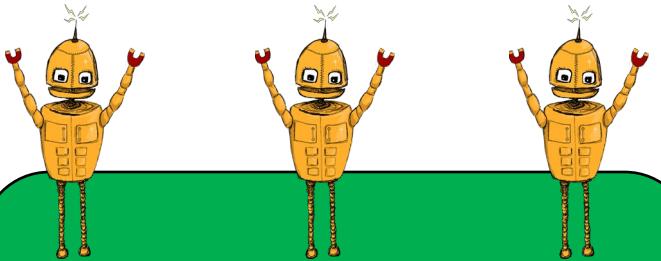


«Problemet» med naturressurser: «Dutch disease»



«Problemet» med naturressurser: «Dutch disease»

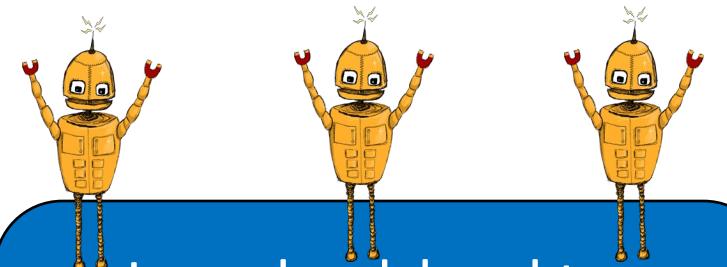
To effekter



Eksport-sektor
(Naturressurser)



Eksport-sektor
(Andre goder)
Tap i konkurranseskraft



Innenlandsk sektor
(handler ikke med
omverden, f.eks. frisører,
håndverker)

1

Eksport-sektoren som produserer naturressursen, og den innenlandske sektoren som ikke handler med omverden, ekspanderer på bekostning av andre eksportsektorer (crowding-out)

«Problemet» med naturressurser:

«Dutch disease»

To effekter

2

Dersom etterspørsels-sjokket ikke er permanent, eller om de økte inntektene til stor del blir brukt til kortsiktig konsum → Stor sjanse for høy inflasjon og gjeldproblematikk



«Problemet» med naturressurser:

«Dutch disease»

Medisin



1

Statsbudsjett-disiplin:
Bruk inntekten fra økt eksport til investeringer.
Invester ikke bare i «boom-sektorer» !

2

Diversifisere eksportsektoren (**ikke bare naturressurser!**)

3

Ha en selvstendig og konservativ sentralbank

4

Ha peiling på det **REALE** vekslekurset

«Problemet» med naturressurser:

«Naturressursenes forbannelse»

Land med mye (ikke fornybare) naturressurser opplever ofte:

- ❖ Lav økonomisk vekst,
- ❖ Lite demokrati og
- ❖ Generelt lite utvikling

Land med betydelig mindre naturressurser har ofte høyere økonomisk vekst, mer demokrati og mer utvikling.

Eksempler

Angola:

Olje, gass, diamanter, mm
HDI = 148/191

Demokratiske republikken Kongo:
Diamanter, gull, kopper, olje mm.

HDI = 179/191

Sierra Leone:

Diamanter, gull, bauksitt, platina mm.
HDI = 181/191

«Problemet» med naturressurser: Naturressursenes forbannelse

Kronisk, forverret versjon av, «the Dutch disease»

«Raske penger» for store aktører (regjeringa, store bedrifter)

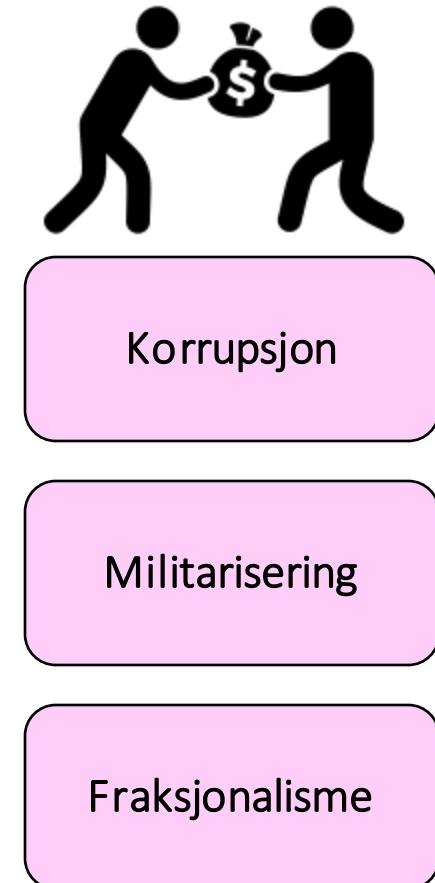
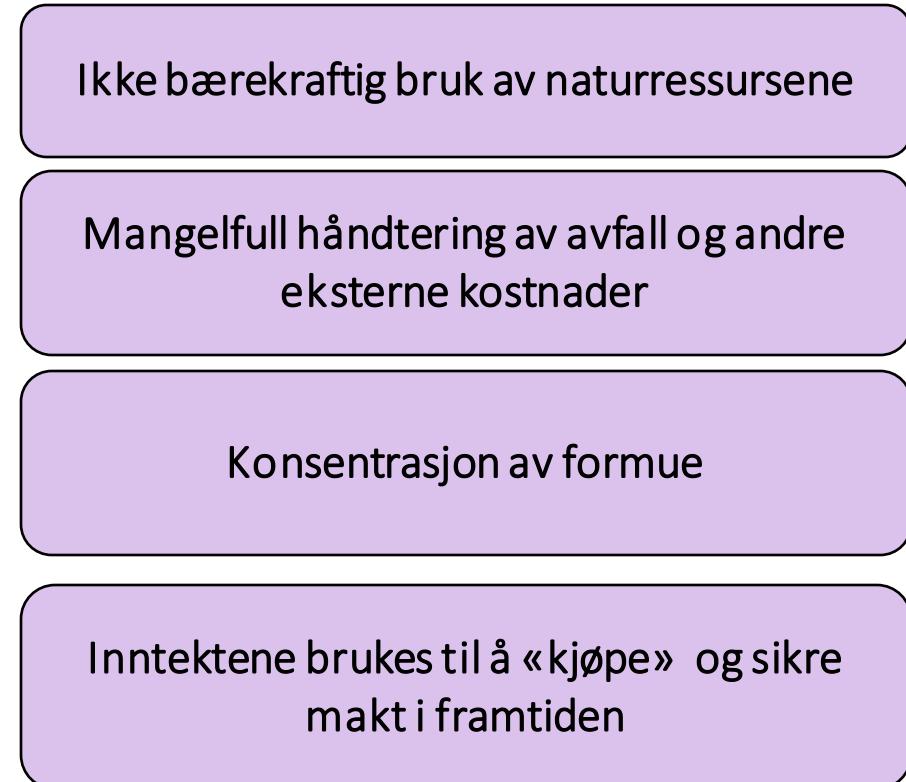
Produsentene bærer ikke hele kostnaden for produksjonen

Potensielt store kostnader for svake grupper i dag og framtidige generasjoner

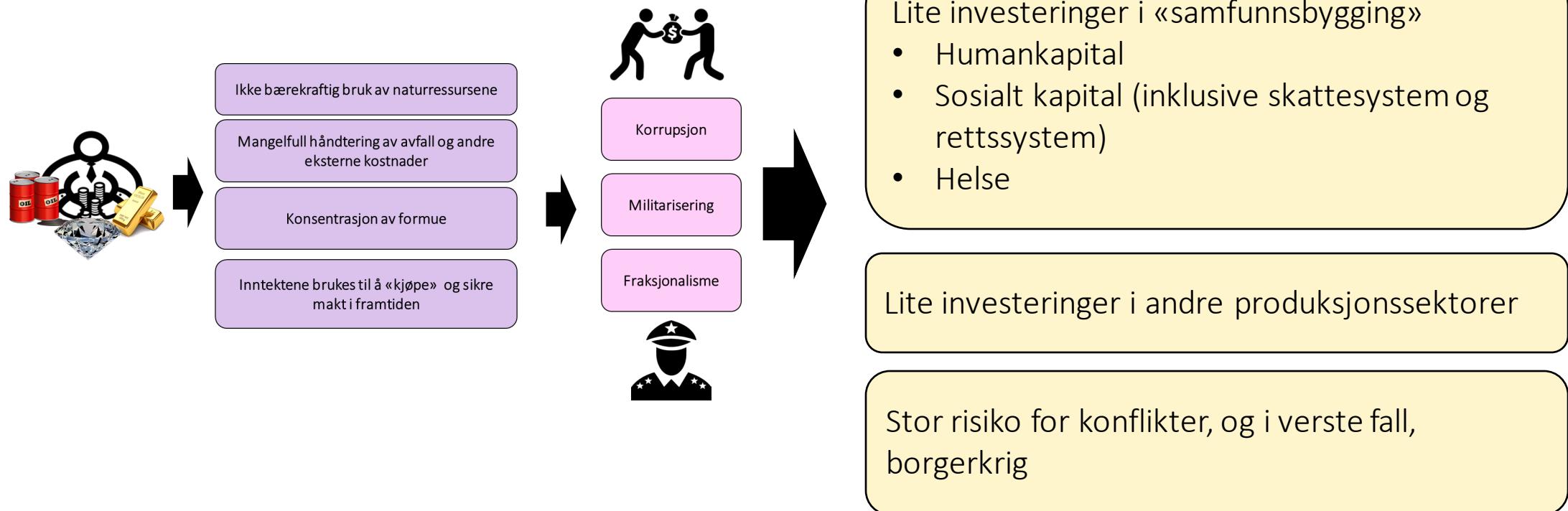
BNP i naturressurs-rike land påvirkes mye av svingninger i priser på
naturressurser på det internasjonale markedet



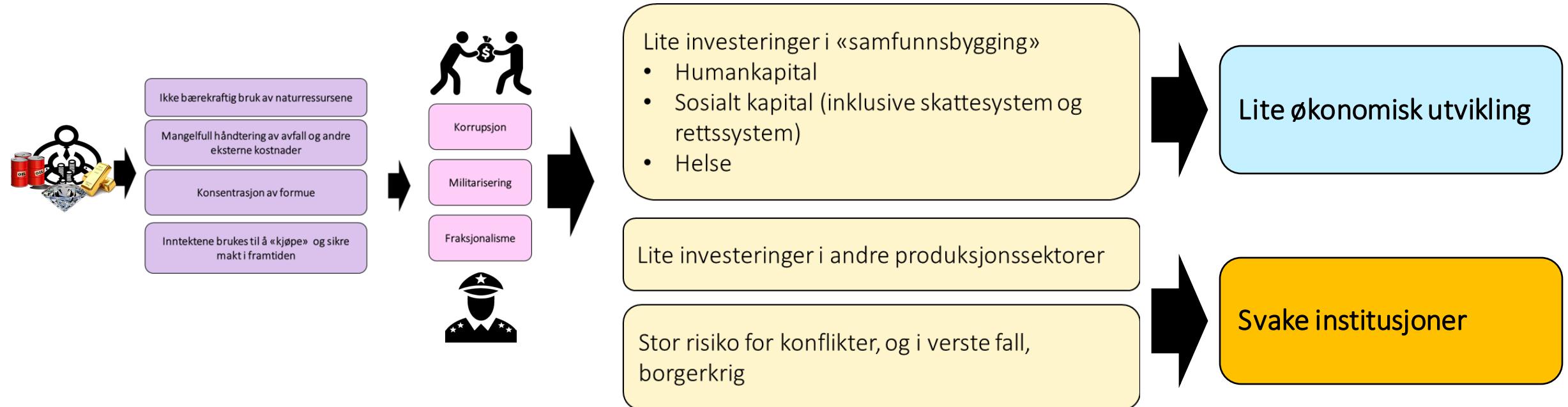
«Problemet» med naturressurser: Naturressursenes forbannelse



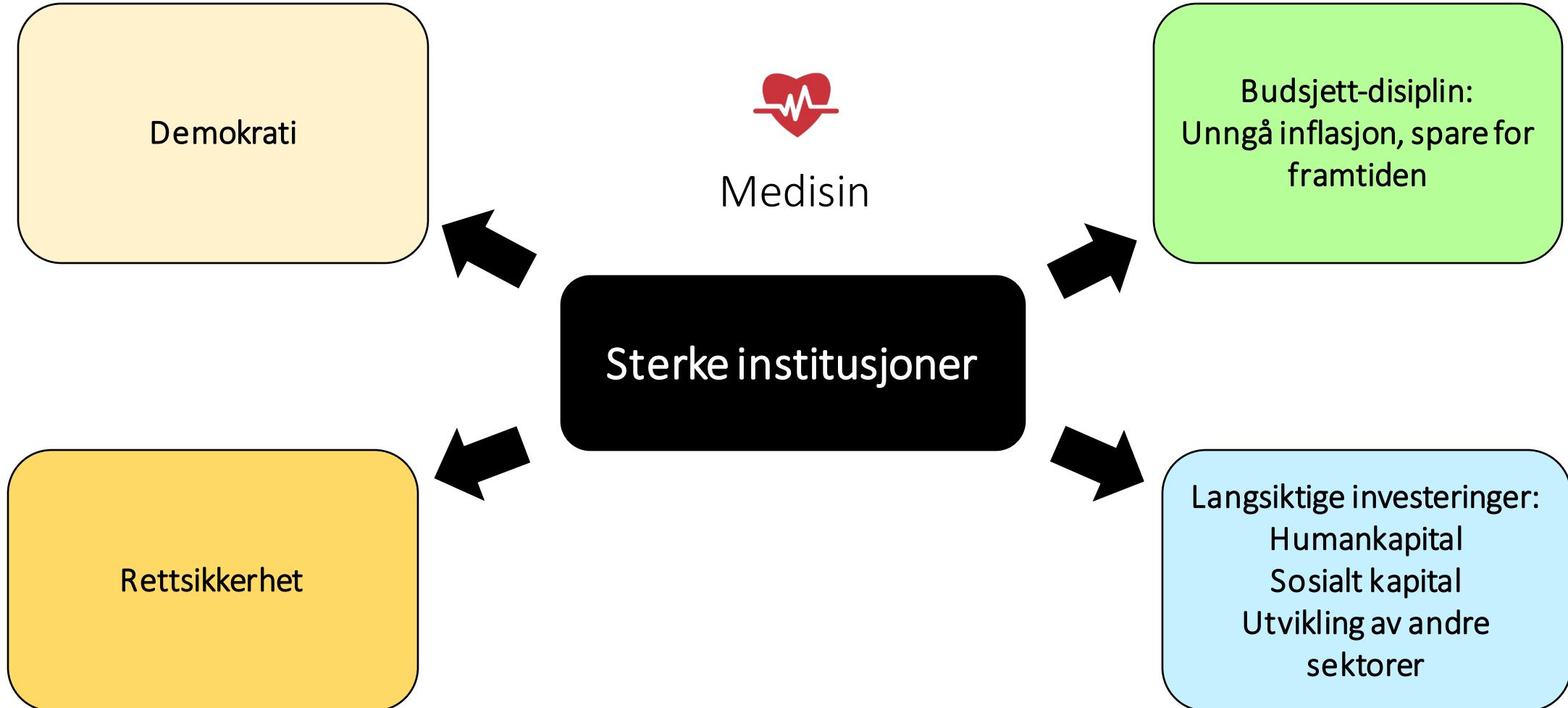
«Problemet» med naturressurser: Naturressursenes forbannelse



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«Problemet» med naturressurser: Naturressursenes forbannelse



«Problemet» med naturressurser: Naturressursenes forbannelse

Omdebattert!

Hvorfor har så mange naturressurs-rike land så svake institusjoner?

Ulike plasser ble kolonialisert på ulike måter

The Colonial Origins of Comparative Development:
An Empirical Investigation

By DARON ACEMOGLU, SIMON JOHNSON, AND JAMES A. ROBINSON*

We exploit differences in European mortality rates to estimate the effect of institutions on economic performance. Europeans adopted very different colonization policies in different colonies, with different associated institutions. In places where Europeans faced high mortality rates, they could not settle and were more likely to set up extractive institutions. These institutions persisted to the present. Exploiting differences in European mortality rates as an instrument for current institutions, we estimate large effects of institutions on income per capita. Once the effect of institutions is controlled for, countries in Africa or those closer to the equator do not have lower incomes. (JEL O11, P16, P51)

<https://www.aeaweb.org/articles?id=10.1257/aer.91.5.1369>



<https://www.nationalgeographic.com/culture/article/colonialism>

Måten ulike land ble kolonialiserte på påvirket oppbygningen av institusjonene i landet

«Problemet» med naturressurser: Naturressursenes forbannelse

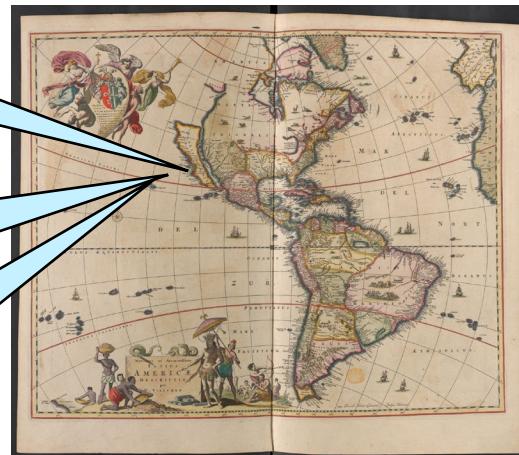
Omdebattert!

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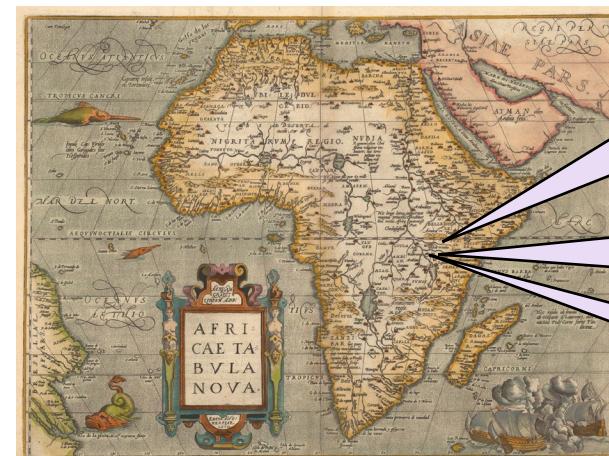
Noen plasser hadde hyggelig klima, og mye dyrkbar mark.

Kolonistene bosatte seg med sine familier og urbefolkingen ble i stort utryddet (av vold og sykdommer).

Kolonistene bygget opp institusjoner for å bygge et samfunn der de ville bo.



<https://www.bl.uk/collection-items/maps-of-the-americas-c-1687>



https://library.princeton.edu/visual_materials/maps/websites/af/rica/maps-continent/continent.html

Andre plasser hadde hett klima, tette skoger, mye sykdommer og naturressurser som kunne «hentes ut».

Her bosatte seg ikke kolonistene. De hentet ut ressurser (naturressurser og arbeidskraft).

Kolonistene bygget kun opp institusjoner for å kunne ekstrahere så mye ressurser som mulig (inkl. å støtte noen grupper mot andre)

Sterke institusjoner

Svake institusjoner

Bærekraftig forvaltning av naturressurser

Et skifte i bekymring

Fra bekymring for at naturressursene skal ta «slutt»

Til bekymring for konsekvenser av bruk av naturressurser, for både klima og mennesker

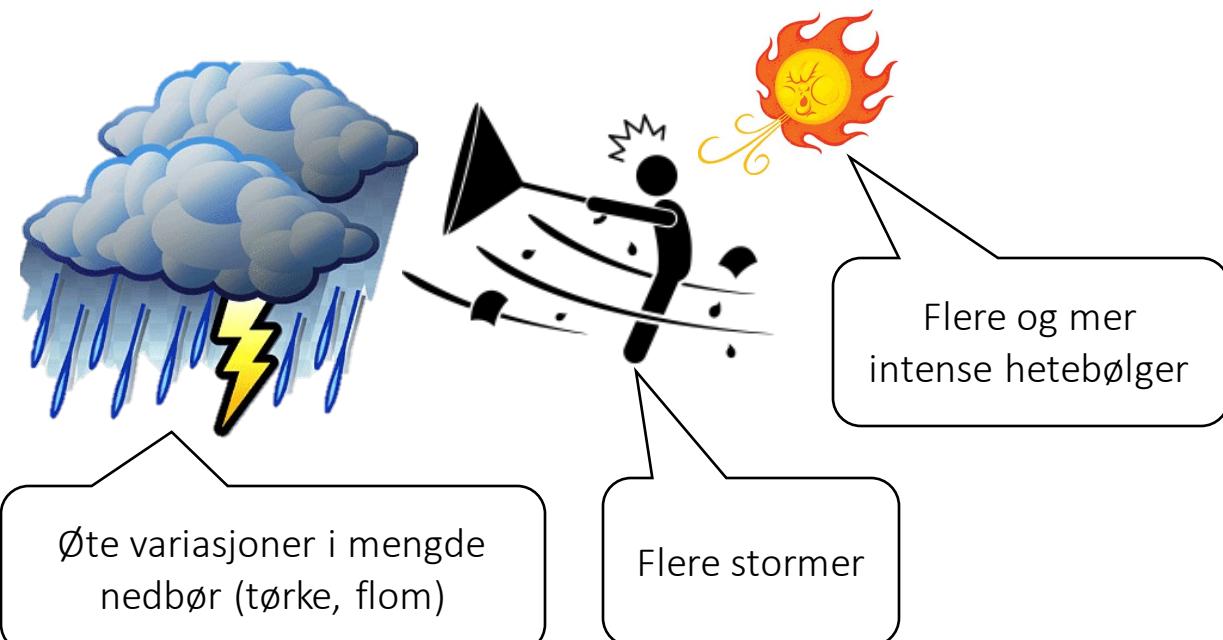
Overforbruk av fornybare ressurser

Effekter av klimaendringer

Forurensing og overforbruk av elver og vann til irrigasjon

Avskoging
(tap av biodiversitet, erosjon, CO₂-absorbisjon)

Overfiske



Bærekraftig forvaltning av (fornybare) naturressurser

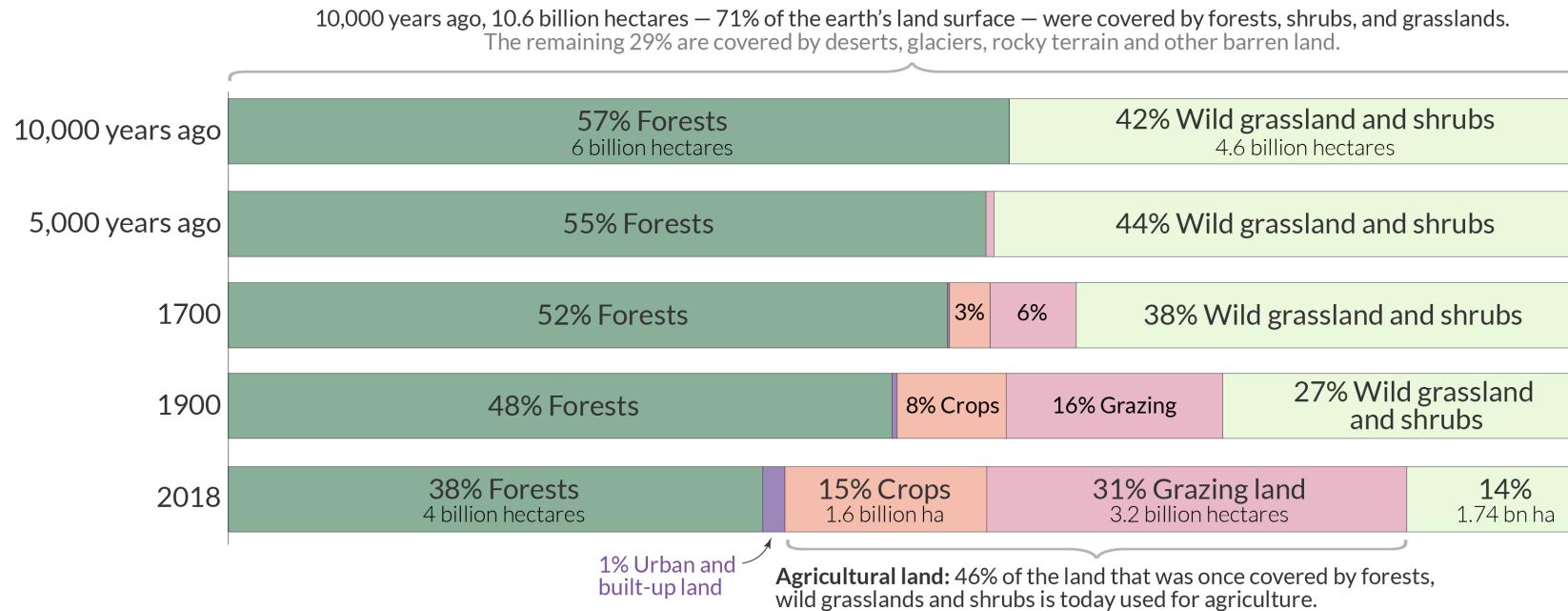
Skog og land



Bærekraftig forvaltning av (fornybare) naturressurser

Humanity destroyed one third of the world's forests by expanding agricultural land

Agriculture is by far the largest driver of deforestation. To bring deforestation to an end humanity has to find ways to produce more food on less land.



The bad news

En svært stor andel av jordens yte blir allerede brukt til å produsere mat og andre goder

Data: Historical data on forests from Williams (2003) – Deforesting the Earth. Historical data on agriculture from The History Database of Global Environment (HYDE). Modern data from the FAO.
OurWorldinData.org – Research and data to make progress against the world's largest problems.

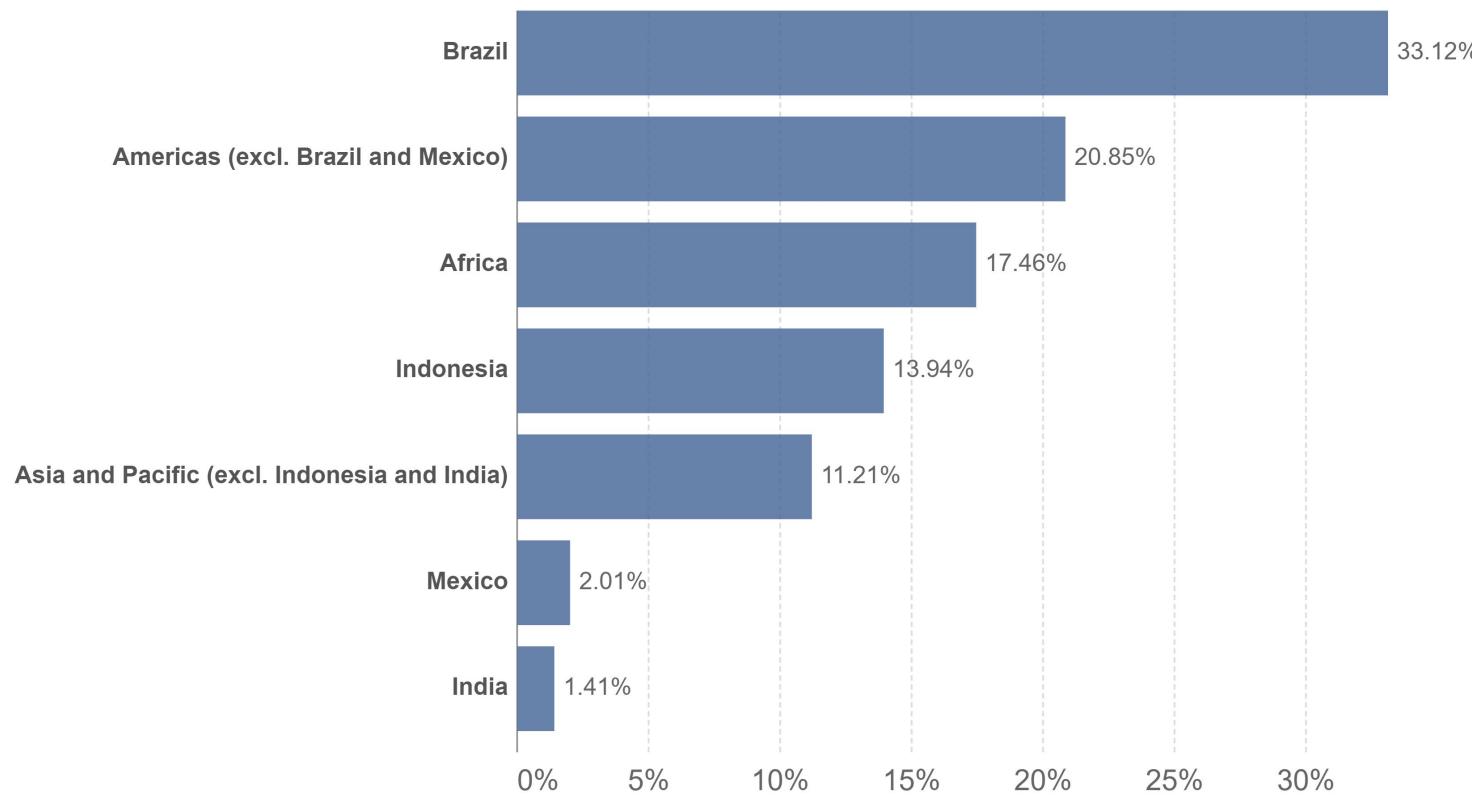
Licensed under CC-BY by the authors Hannah Ritchie and Max Roser.

Bærekraftig forvaltning av (fornybare) naturressurser

Share of tropical deforestation

Share of tropical deforestation from commodity production – this includes forest clearance for croplands, pasture and tree plantations for logging. It's measured as the annual average between 2010 and 2014.

Our World
in Data



The bad guys?
(ikke helt sant)

Et fåtal land står
for mesteparten
av avskogingen i
tropiske skoger

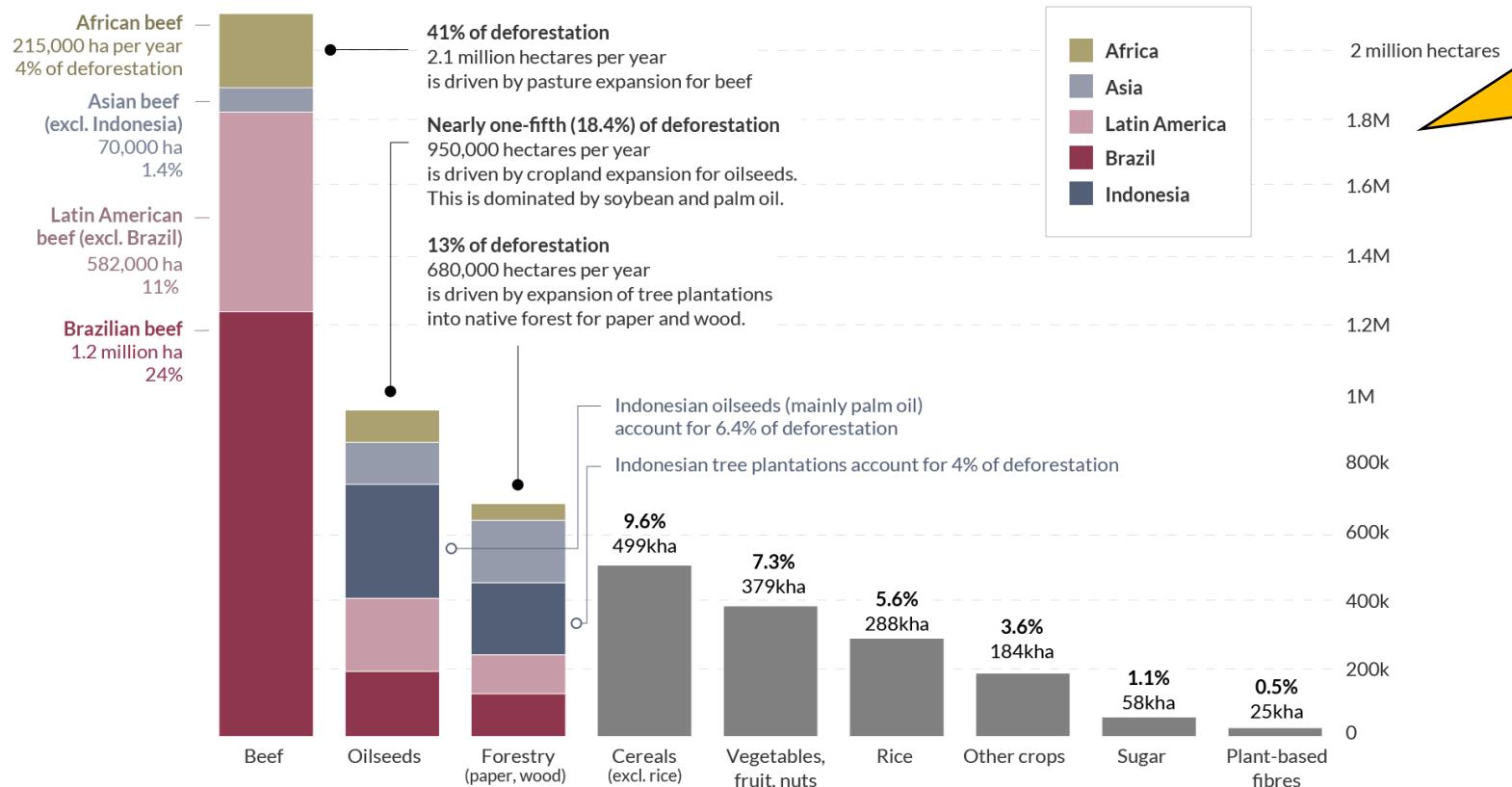
Source: Pendrill et al. (2019). Agricultural and forestry trade drives large share of tropical deforestation emissions.
[OurWorldInData.org/forests-and-deforestation](https://ourworldindata.org/forests-and-deforestation) • CC BY

Bærekraftig forvaltning av (fornybare) naturressurser

What are the drivers of tropical deforestation?

Our World
in Data

Nearly all of global deforestation occurs in tropical and subtropical countries. 70% to 80% is driven by conversion of primary forest to agriculture or tree plantations. Shown is the breakdown of these drivers averaged over the years 2005 to 2013. Further observations since 2013 suggest that drivers have not changed substantially over this period.



The big bad cow and the good seeds?

Produksjonen av storfekjøtt er en av de fremste drivkraftene bak avskogingen av tropiske skoger

Data source: Florence Pendrill et al. (2019). Deforestation displaced: trade in forest-risk commodities and the prospects for a global forest transition.

OurWorldInData.org - Research and data to make progress against the world's largest problems.

Licensed under CC-BY by the author Hannah Ritchie.

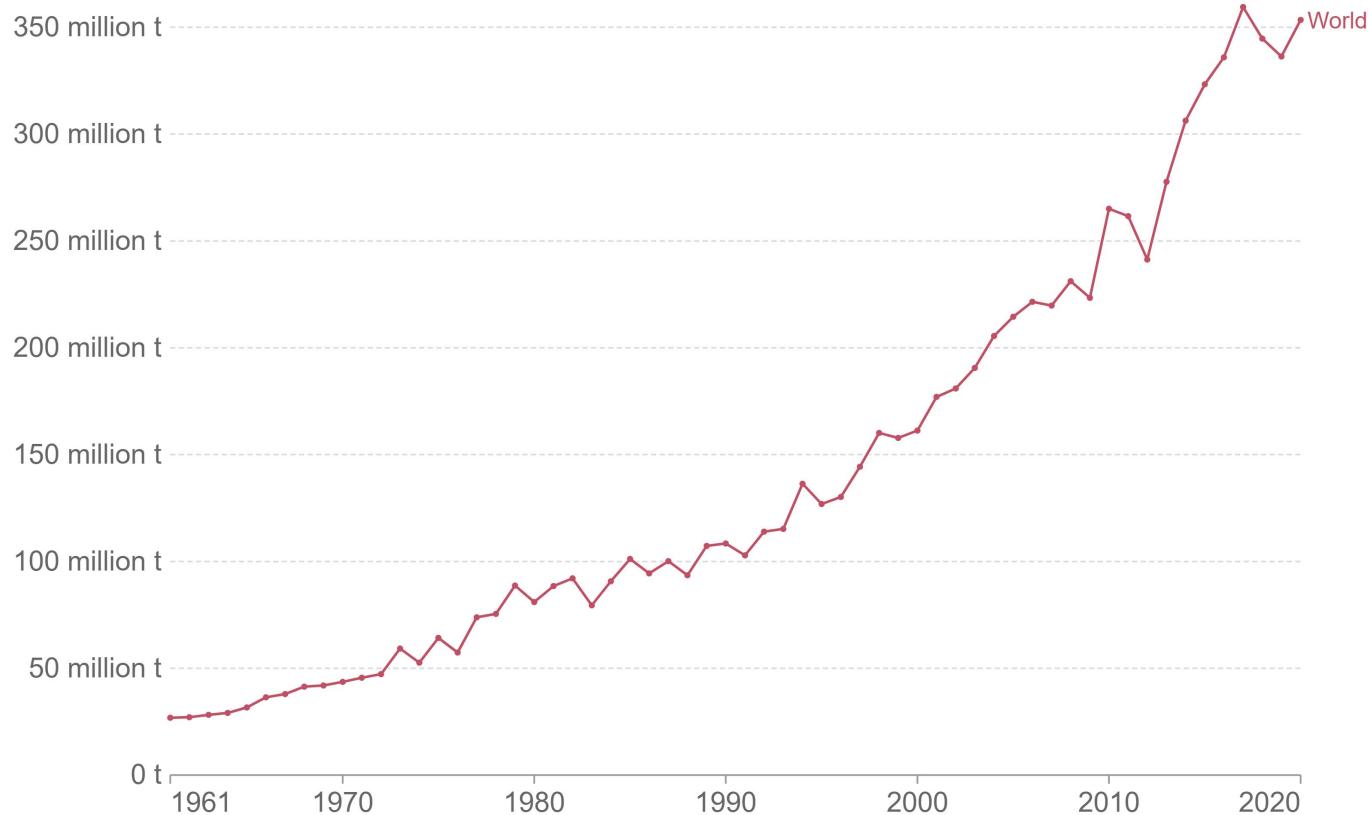
Les mer: <https://ourworldindata.org/drivers-of-deforestation#cutting-down-forests-what-are-the-drivers-of-deforestation>

Bærekraftig forvaltning av (fornybare) naturressurser

Soybean production

Soybean production is measured in tonnes.

Our World
in Data



Source: Food and Agriculture Organization of the United Nations

OurWorldInData.org/agricultural-production • CC BY

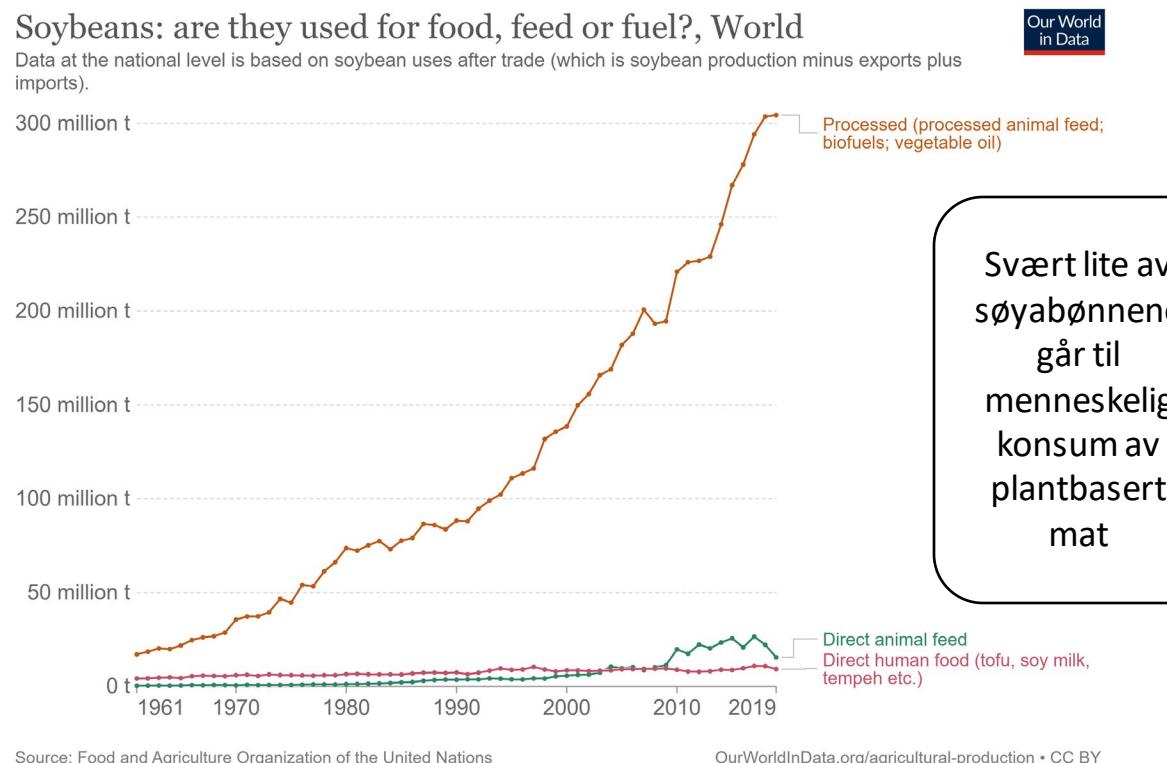
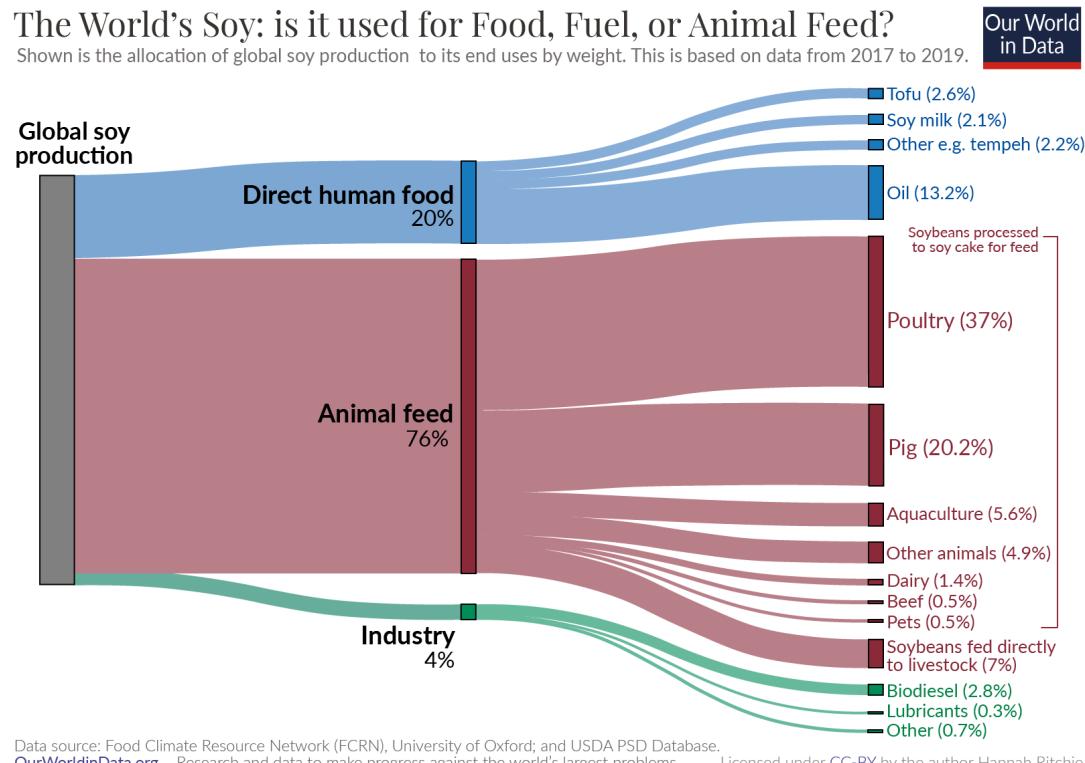
One bad seed?

Er det verre å spise
soyabønner enn
kjøtt?

Les mer: <https://ourworldindata.org/drivers-of-deforestation#cutting-down-forests-what-are-the-drivers-of-deforestation>

Bærekraftig forvaltning av (fornybare) naturressurser

One bad seed?



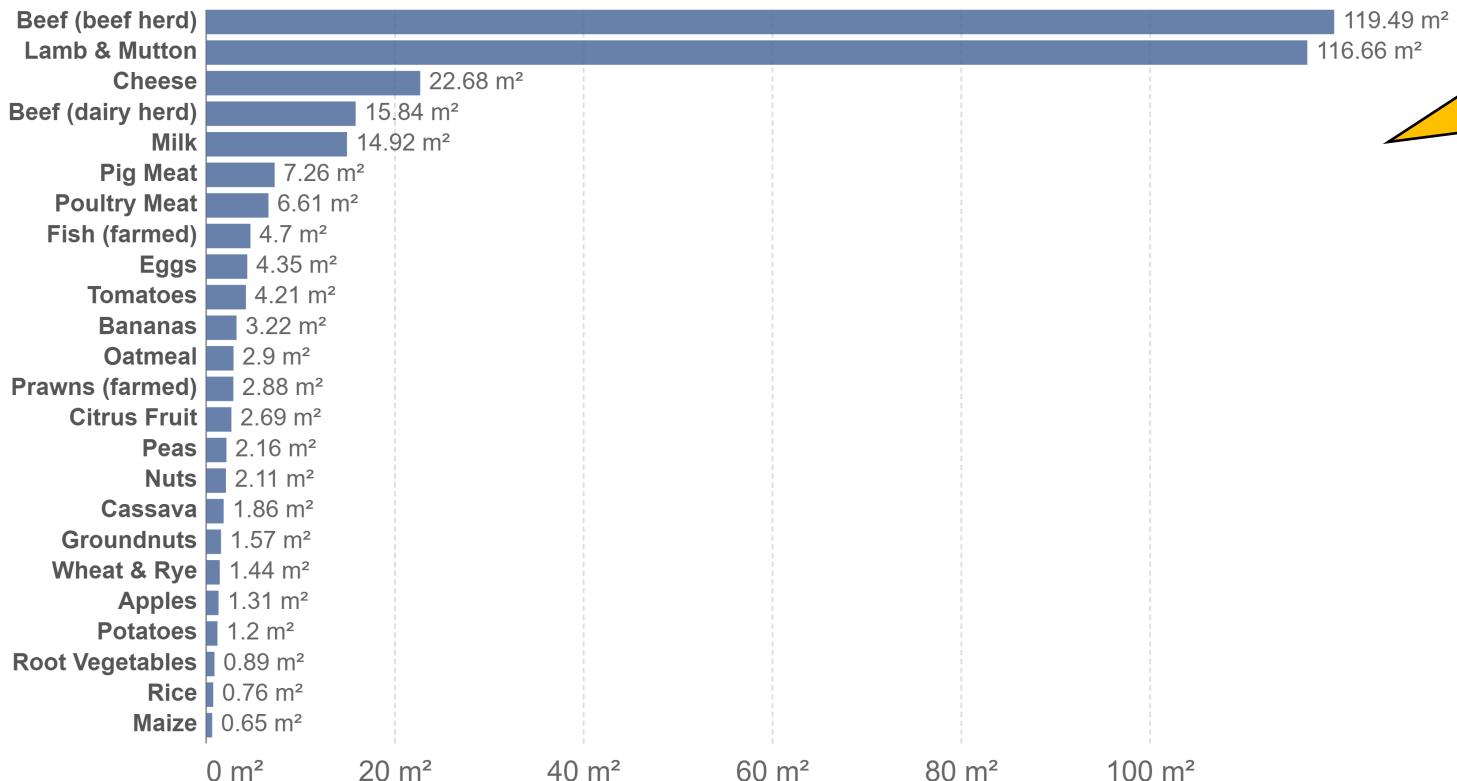
Les mer: <https://ourworldindata.org/drivers-of-deforestation#cutting-down-forests-what-are-the-drivers-of-deforestation>

Bærekraftig forvaltning av (fornybare) naturressurser

Land use of foods per 1000 kilocalories

Land use is measured in meters squared (m^2) required to produce 1000 kilocalories of a given food product.

Our World
in Data



The big bad cow
and
the good seeds

Source: Joseph Poore and Thomas Nemecek (2018). Additional calculations by Our World in Data.

Note: The median year of the studies involved in this research was 2010.

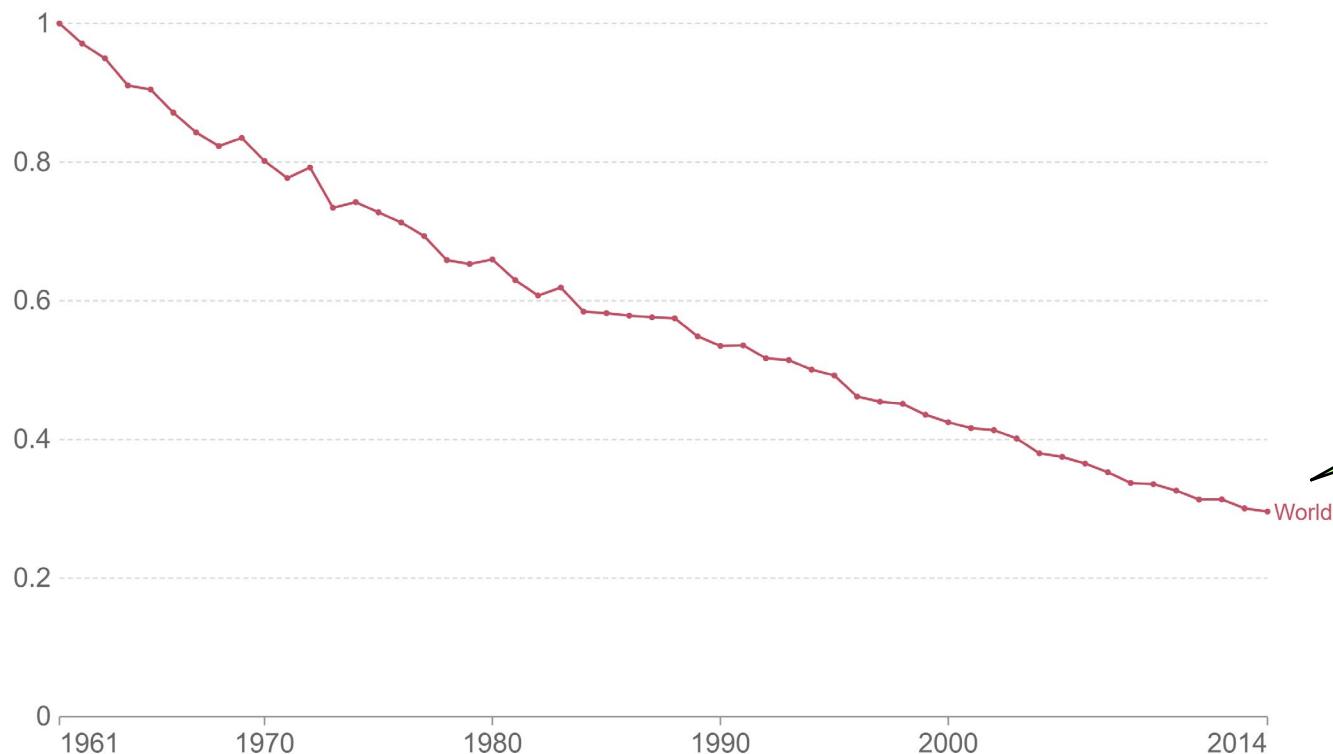
[OurWorldInData.org/environmental-impacts-of-food](https://ourworldindata.org/environmental-impacts-of-food) • CC BY

Bærekraftig forvaltning av (fornybare) naturressurser

Arable land needed to produce a fixed quantity of crops, 1961 to 2014

Arable land needed to produce a fixed quantity of crops is calculated as arable land divided by the crop production index (PIN). The crop production index (PIN) here is the sum of crop commodities (minus crops used for animal feed), weighted by commodity prices. This is measured as an index relative to 1961 (where 1961 = 1).

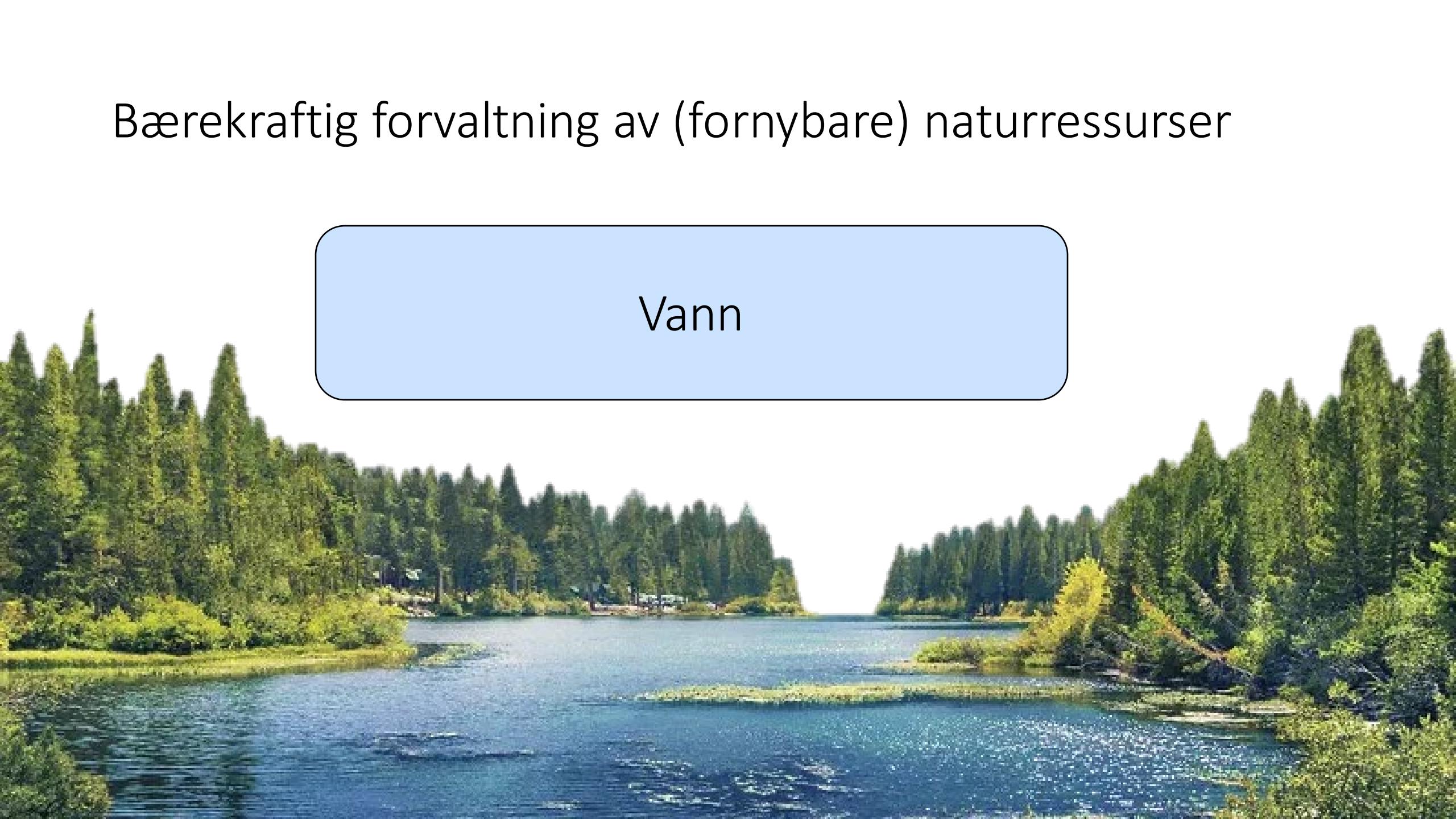
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The (somewhat) good news

Mengden land som trengs for å produsere en gitt mengde mat har minket drastisk over tid, som følge av teknologisk utvikling

Bærekraftig forvaltning av (fornybare) naturressurser

A wide-angle photograph of a serene lake. The water is a deep blue-green color, reflecting the clear sky above. On either side of the lake, there are large, dense forests of tall, thin evergreen trees. In the center of the lake, there is a small, rocky island covered in green vegetation. The overall scene is peaceful and natural.

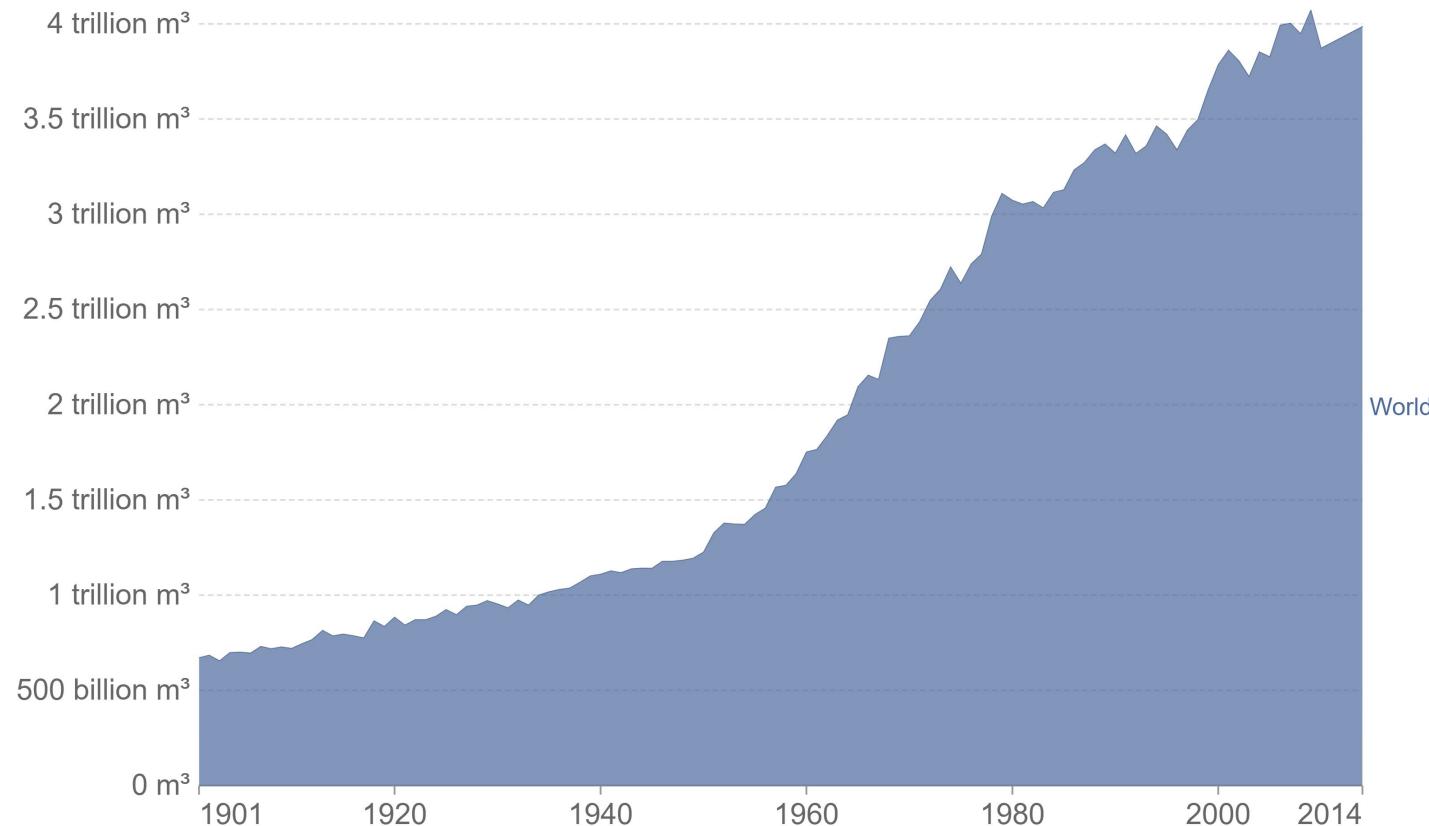
Vann

Bærekraftig forvaltning av (fornybare) naturressurser

Global freshwater use over the long-run

Global freshwater withdrawals for agriculture, industry and domestic uses since 1900, measured in cubic metres (m^3) per year.

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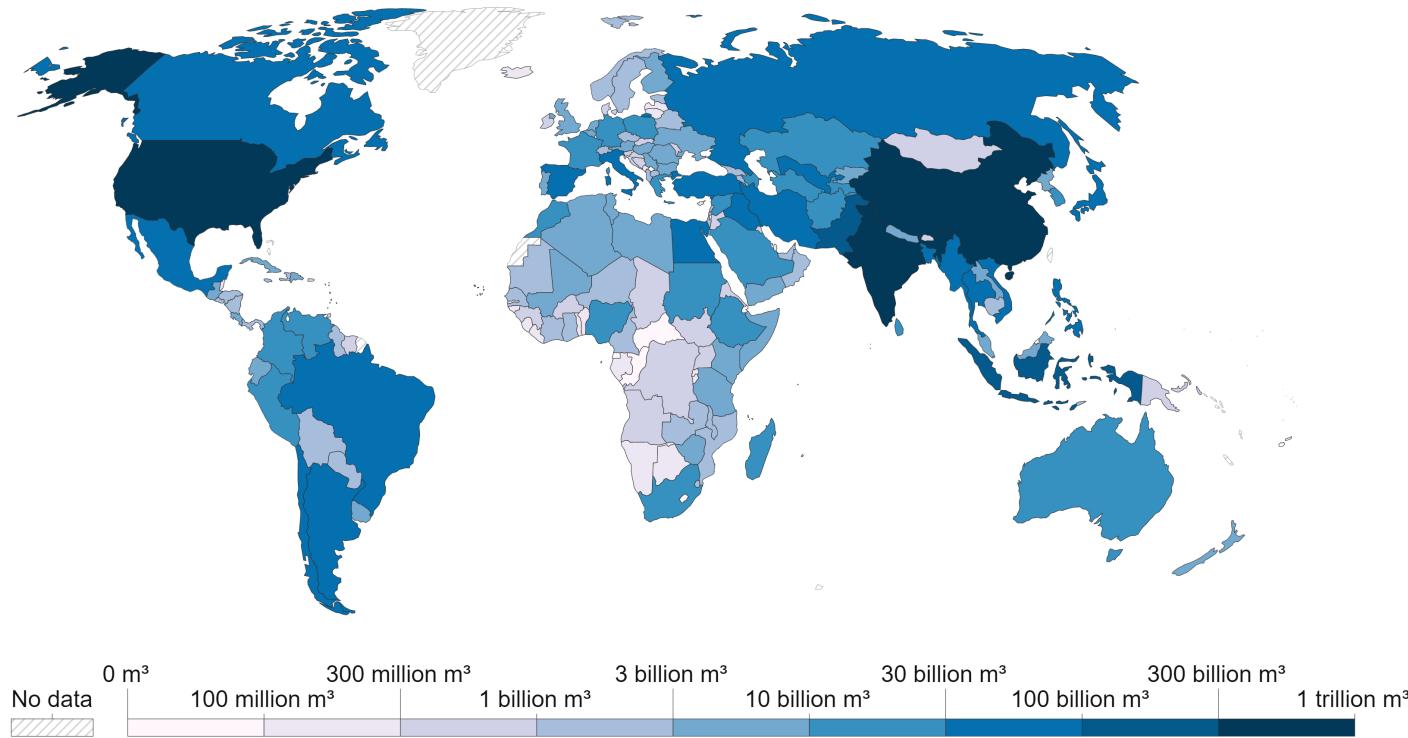
Verdens behov av ferskvann
øker stadig vekk

Bærekraftig forvaltning av (fornybare) naturressurser

Annual freshwater withdrawals, 2017

Annual freshwater withdrawals refer to total water withdrawals, not counting evaporation losses from storage basins, measured in cubic metres (m^3) per year. Total water withdrawals are the sum of withdrawals for agriculture, industry and municipal (domestic) uses. Withdrawals also include water from desalination plants in countries where they are a significant source.

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Source: Food and Agriculture Organization of the United Nations (via World Bank)

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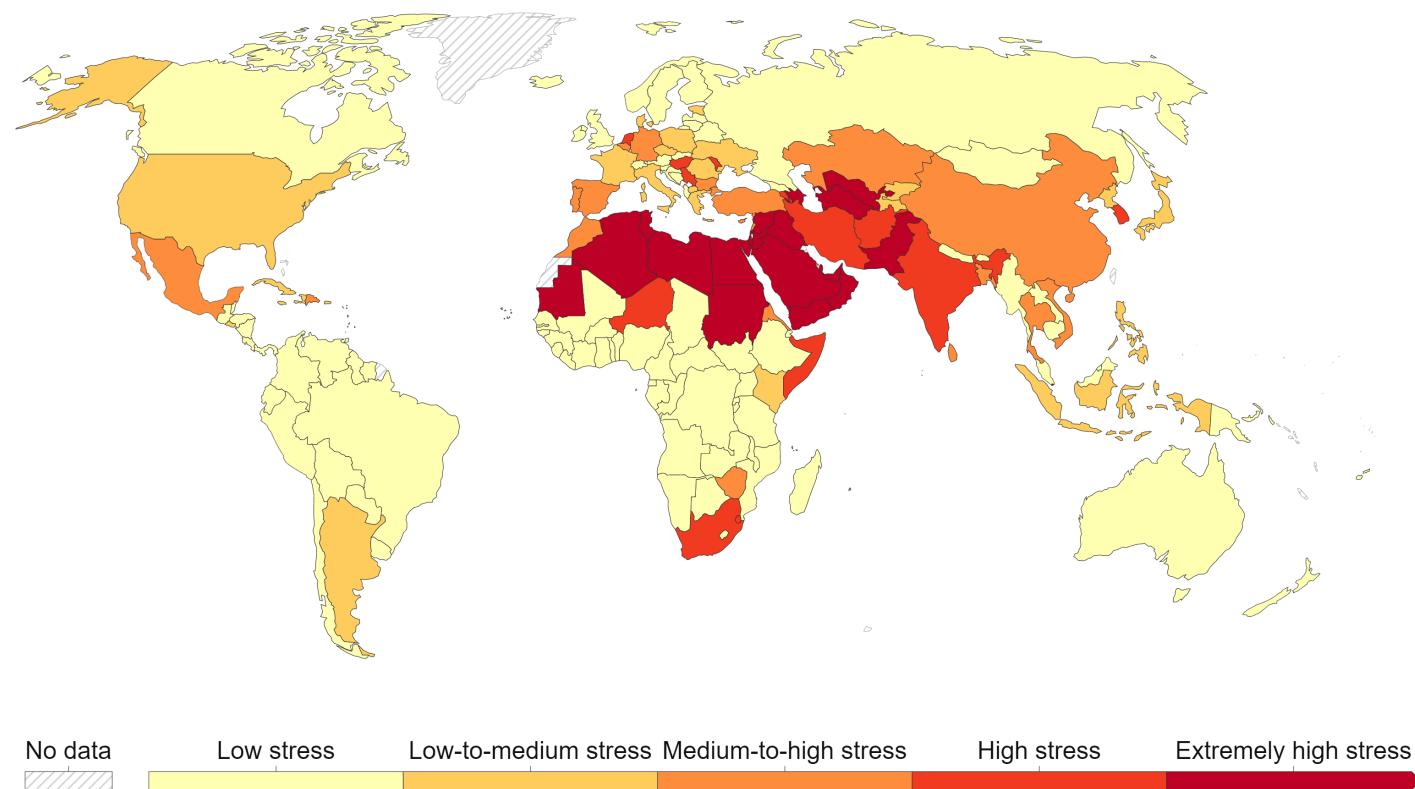
Store variasjoner i hvor mye vann som blir brukt til produksjon og direkte konsum i ulike land og ulike regioner i verden

Bærekraftig forvaltning av (fornybare) naturressurser

Freshwater withdrawals as a share of internal resources, 2017

Annual freshwater withdrawals refer to total water withdrawals from agriculture, industry and municipal/domestic uses. Withdrawals can exceed 100% of total renewable resources where extraction from nonrenewable aquifers or desalination plants is considerable.

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Source: Food and Agriculture Organization of the United Nations

OurWorldInData.org/water-use-stress • CC BY

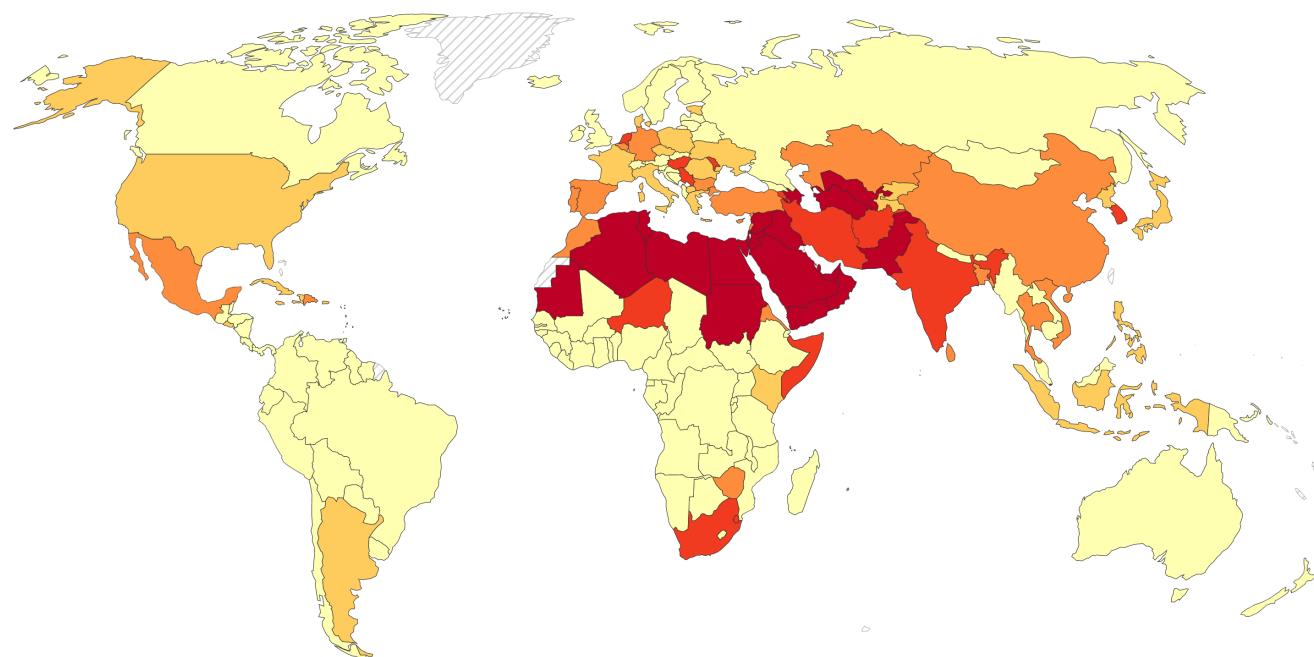
Store variasjoner i hvor mye vann som blir brukt i forhold til hvor mye vann som finns tilgjengelig i et land.

Bærekraftig forvaltning av (fornybare) naturressurser

Freshwater withdrawals as a share of internal resources, 2017

Annual freshwater withdrawals refer to total water withdrawals from agriculture, industry and municipal/domestic uses. Withdrawals can exceed 100% of total renewable resources where extraction from nonrenewable aquifers or desalination plants is considerable.

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No data

Low stress

Low-to-medium stress

Medium-to-high stress

High stress

Extremely high stress

Source: Food and Agriculture Organization of the United Nations

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UNICEF estimerer at 4 milliarder mennesker opplever alvorlig vannmangel minst 1 måned per år

I 2030 beregner UNICEF at 700 millioner vil være på flukt som følge av vannmangel

Klimaendringer

«Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or variability of its properties, and that persists for an extended period, typically decades or longer»

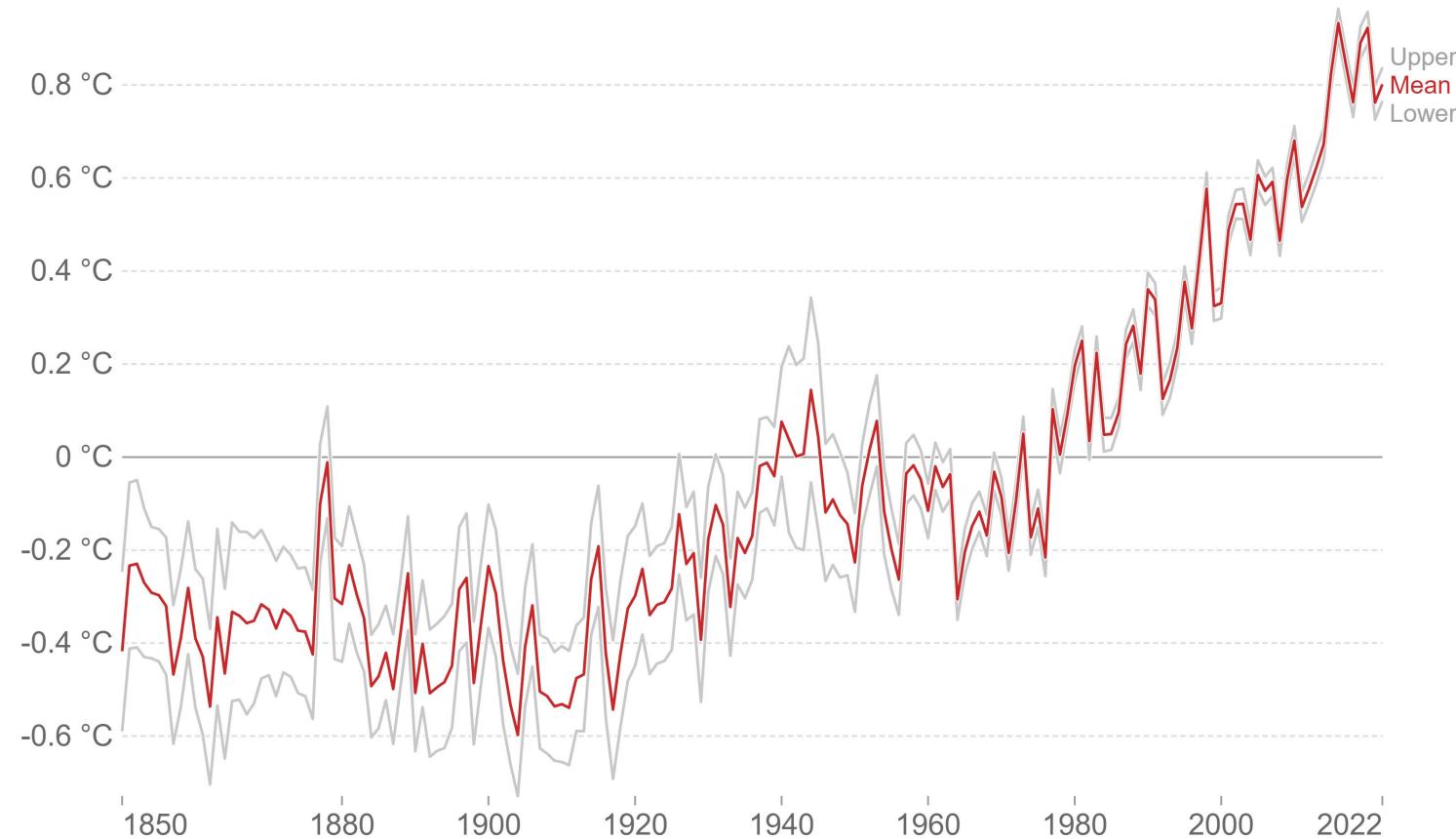
IPCC 2014:5

Klimaendringer

Average temperature anomaly, Global

Global average land-sea temperature anomaly relative to the 1961-1990 average temperature.

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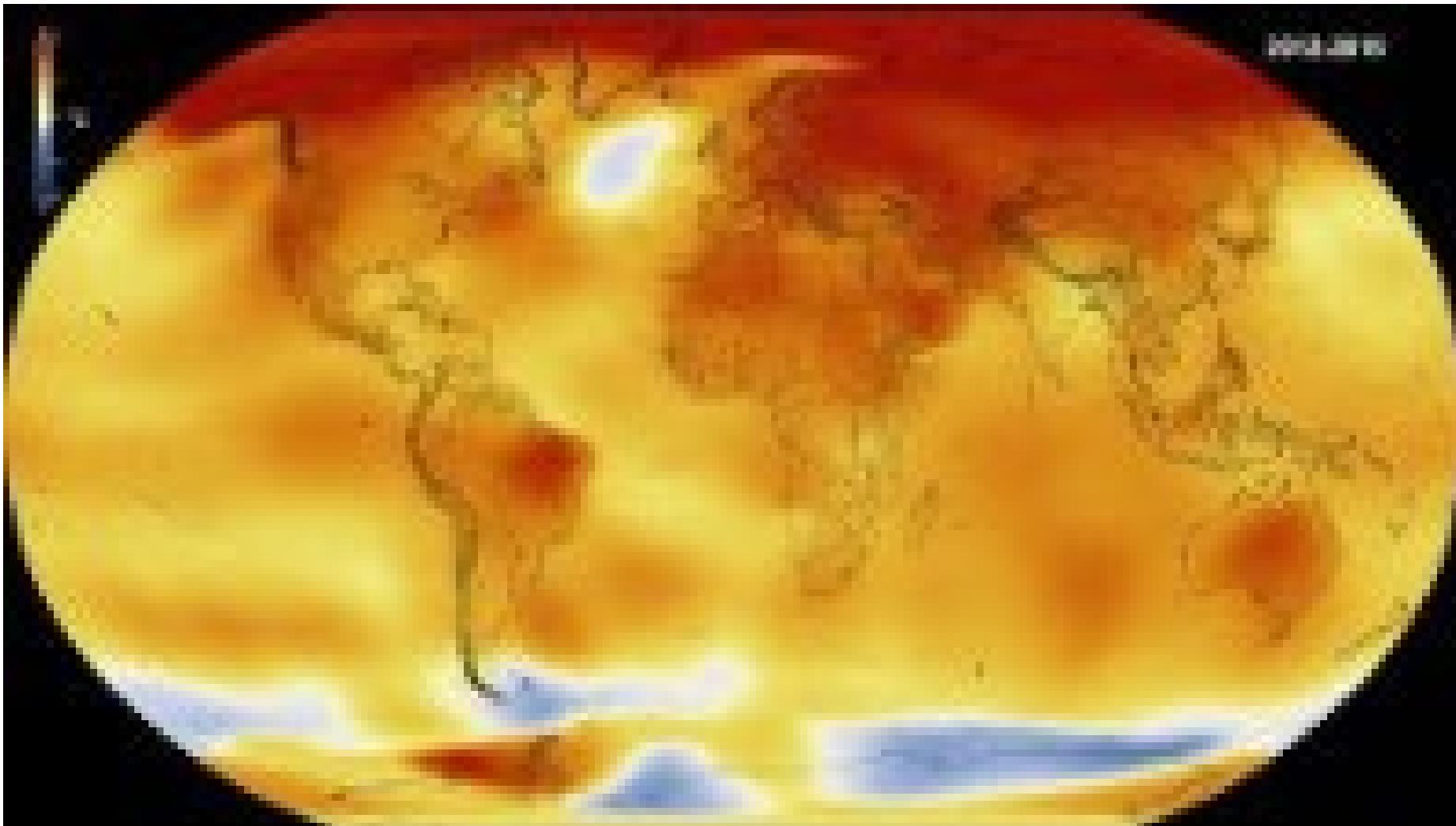
Source: Met Office Hadley Centre (HadCRUT5)

Note: The gray lines represent the upper and lower bounds of the 95% confidence intervals.

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Statistisk signifikant endring i
temperatur over tid

Klimaendringer



Klimaendringer

Dersom temperaturøkningen er mindre enn +2°C fra den førindustrielle perioden, *kan* det være mulig å unngå store tap av is fra breene på Grønland og Antarktis.

Verdensbanken

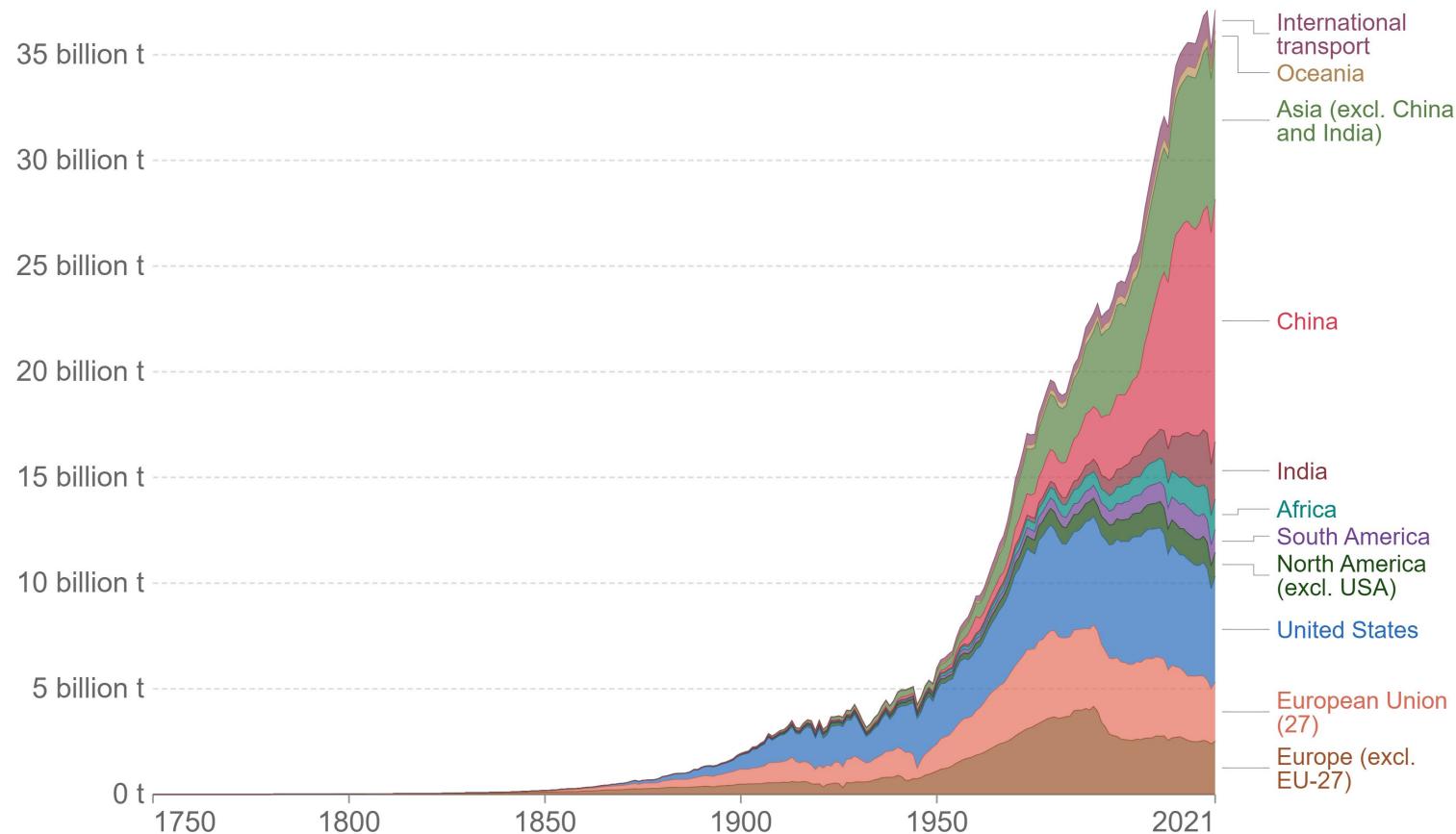
I 2050 må utslippene av klimagass være 50% av nivået 1990
(konsentrasjonen av klimagass i atmosfæren må være mindre enn 450 ppm CO₂ ekvivalenter)

Utslipp av klimagass

Annual CO₂ emissions by world region

This measures fossil fuel and industry emissions¹. Land use change is not included.

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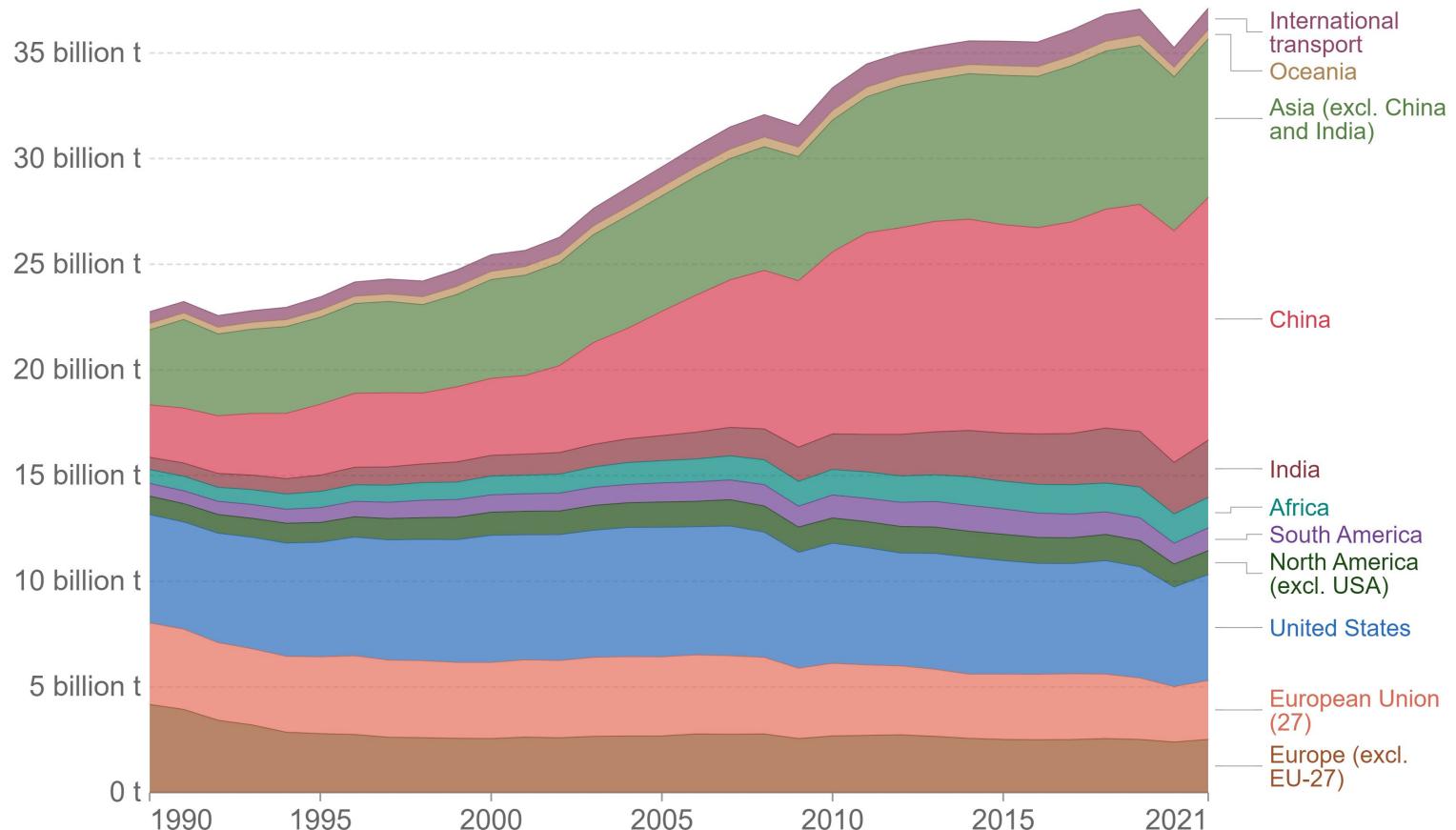


Utslipp av klimagass

Annual CO₂ emissions by world region

This measures fossil fuel and industry emissions¹. Land use change is not included.

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in Data

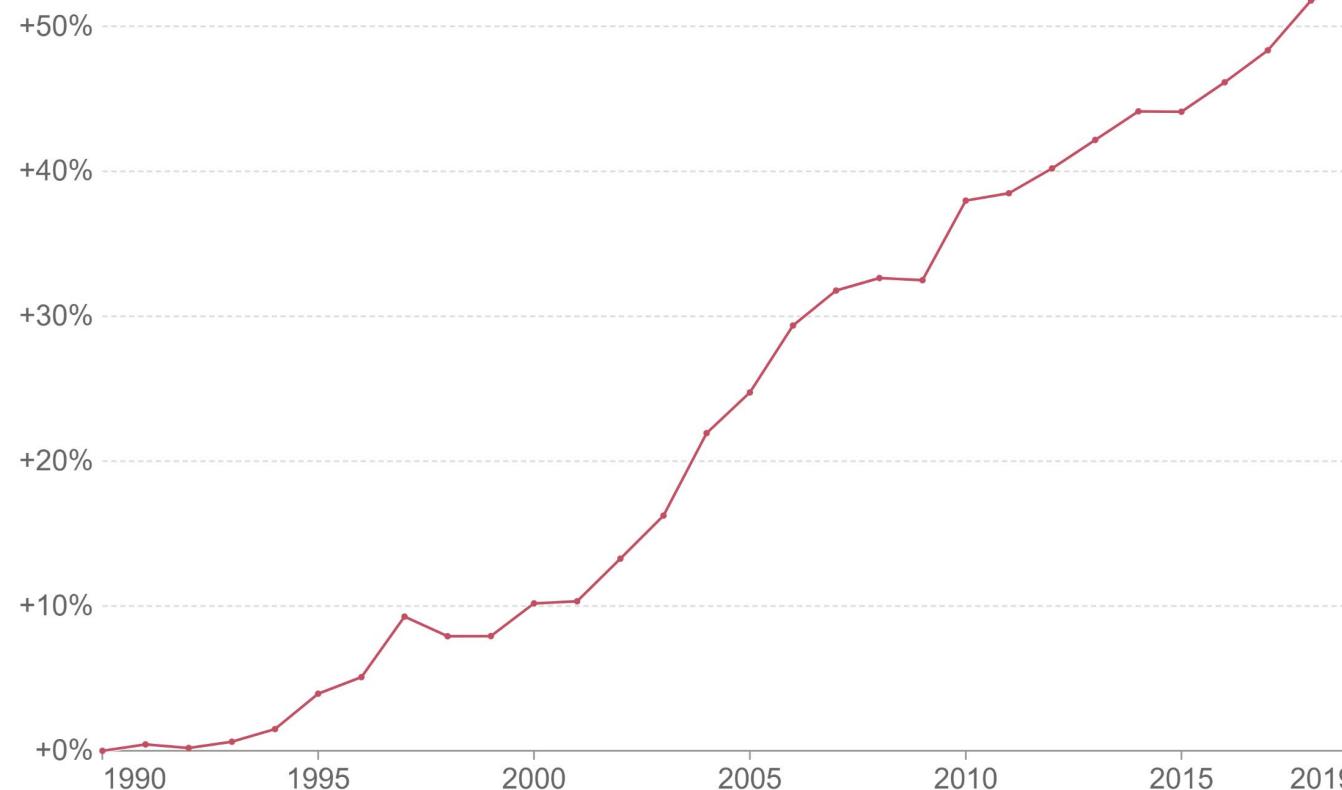


Utslipp av klimagass

Change in total greenhouse gas emissions

Greenhouse gas emissions¹ are measured in carbon dioxide-equivalents (CO₂eq)². Emissions from land use change – which can be positive or negative – are taken into account.

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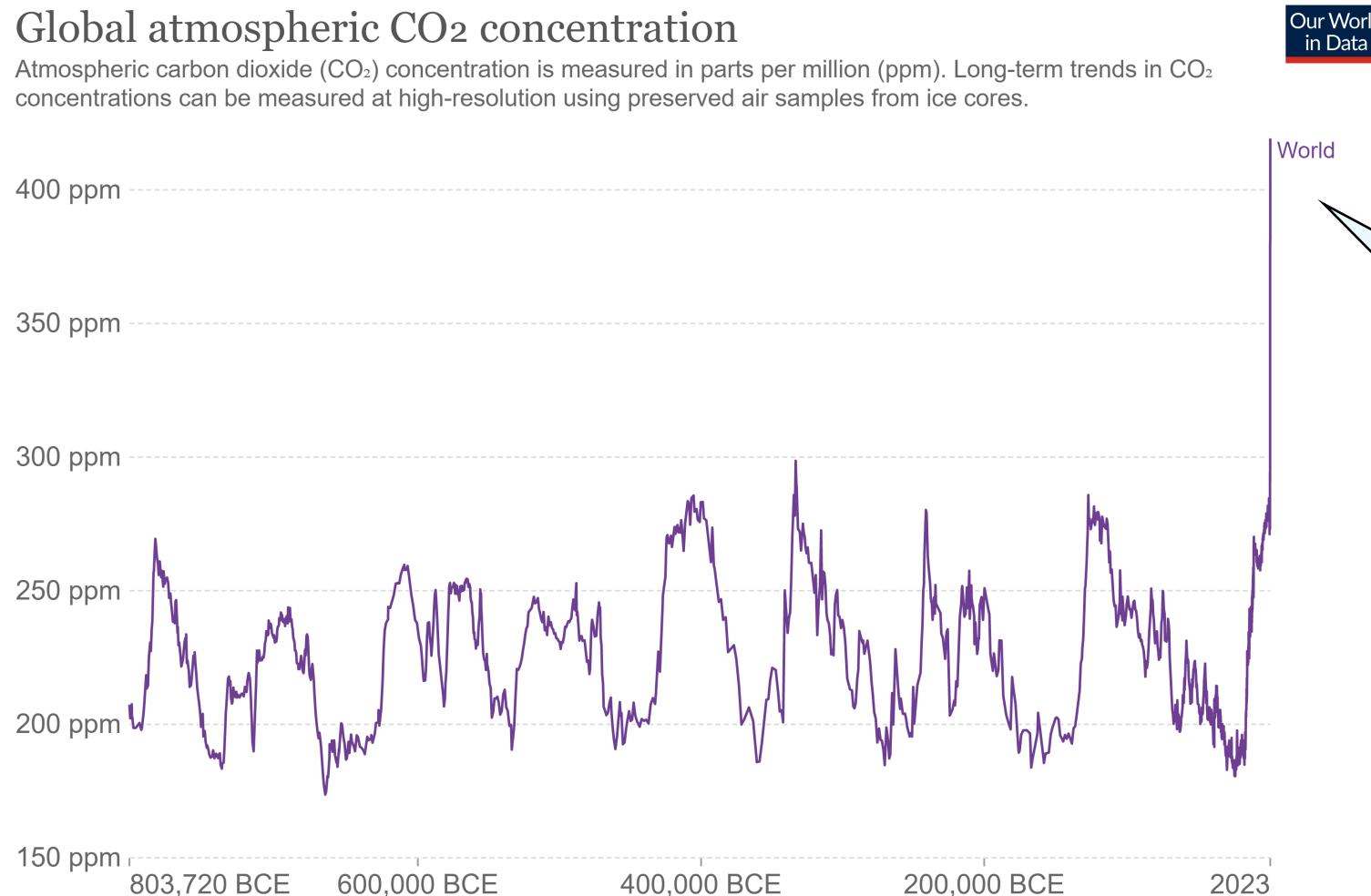
I 2050 må utslippene av klimagass være 50% av nivået 1990
(450 ppm CO₂ ekvivalenter)

I 2019 hadde utslippene av klimagass økt med 50% fra 1990

Utslipp av klimagass

Global atmospheric CO₂ concentration

Atmospheric carbon dioxide (CO₂) concentration is measured in parts per million (ppm). Long-term trends in CO₂ concentrations can be measured at high-resolution using preserved air samples from ice cores.



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World

I 2050 får ikke konsentrasjonen av klimagass i atmosfæren være høyere enn **450 ppm CO₂ ekvivalenter**

I 2019 var konsentrasjonen av klimagass i atmosfæren **419.24 ppm CO₂ ekvivalenter**

Global greenhouse gas emissions and warming scenarios

- Each pathway comes with uncertainty, marked by the shading from low to high emissions under each scenario.
- Warming refers to the expected global temperature rise by 2100, relative to pre-industrial temperatures.

Annual global greenhouse gas emissions
in gigatonnes of carbon dioxide-equivalents

150 Gt

100 Gt

50 Gt

Greenhouse gas emissions
up to the present

0

1990 2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 2100

No climate policies
 $4.1 - 4.8^{\circ}\text{C}$

→ expected emissions in a baseline scenario if countries had not implemented climate reduction policies.

Current policies
 $2.5 - 2.9^{\circ}\text{C}$

→ emissions with current climate policies in place result in warming of 2.5 to 2.9°C by 2100.

Pledges & targets (2.1 °C)
→ emissions if all countries delivered on reduction pledges result in warming of 2.1°C by 2100.

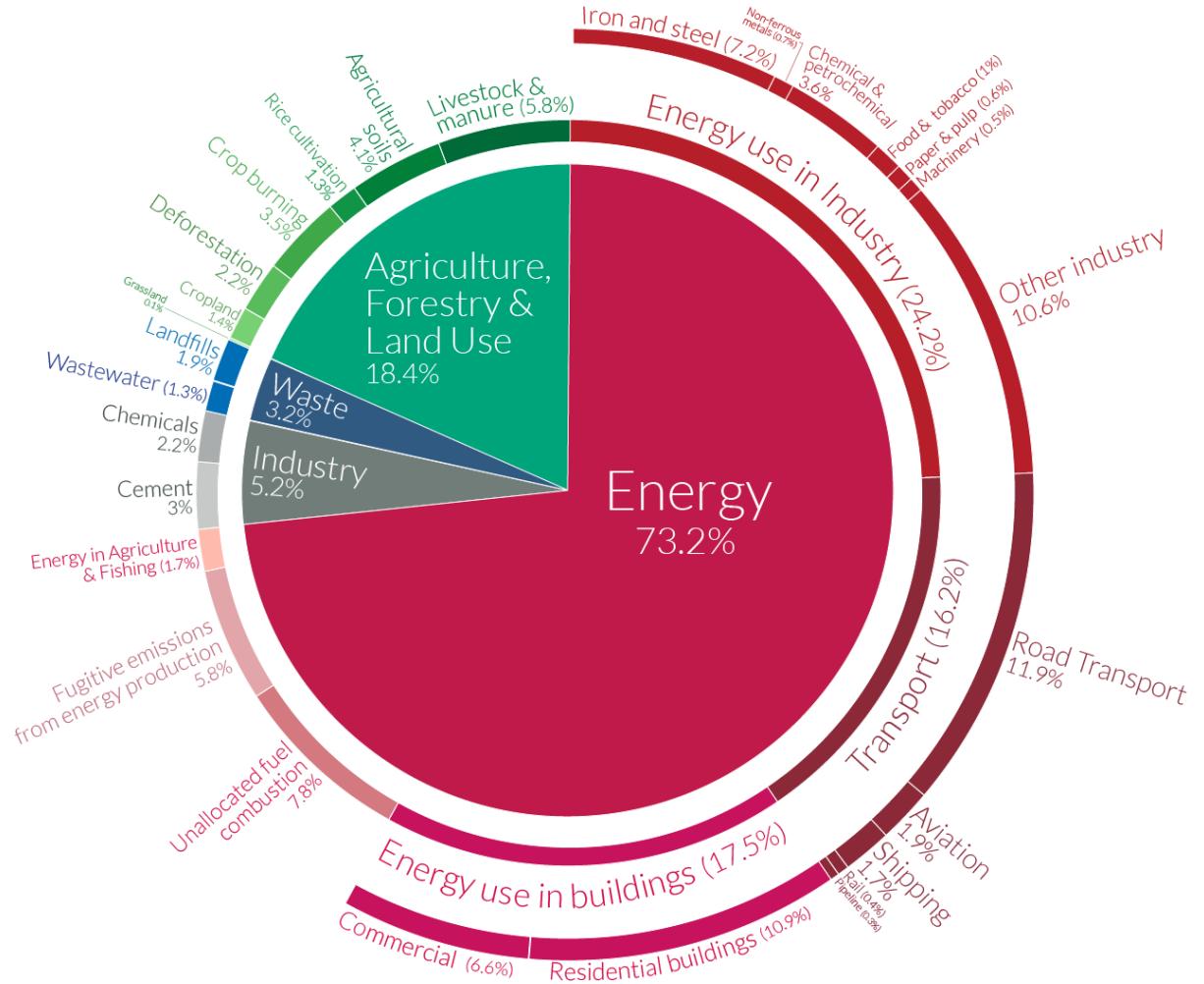
2°C pathways
1.5°C pathways

Hvor kommer klimagassen ifra?

Global greenhouse gas emissions by sector

This is shown for the year 2016 – global greenhouse gas emissions were 49.4 billion tonnes CO₂eq.

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OurWorldinData.org – Research and data to make progress against the world's largest problems.

Source: Climate Watch, the World Resources Institute (2020).

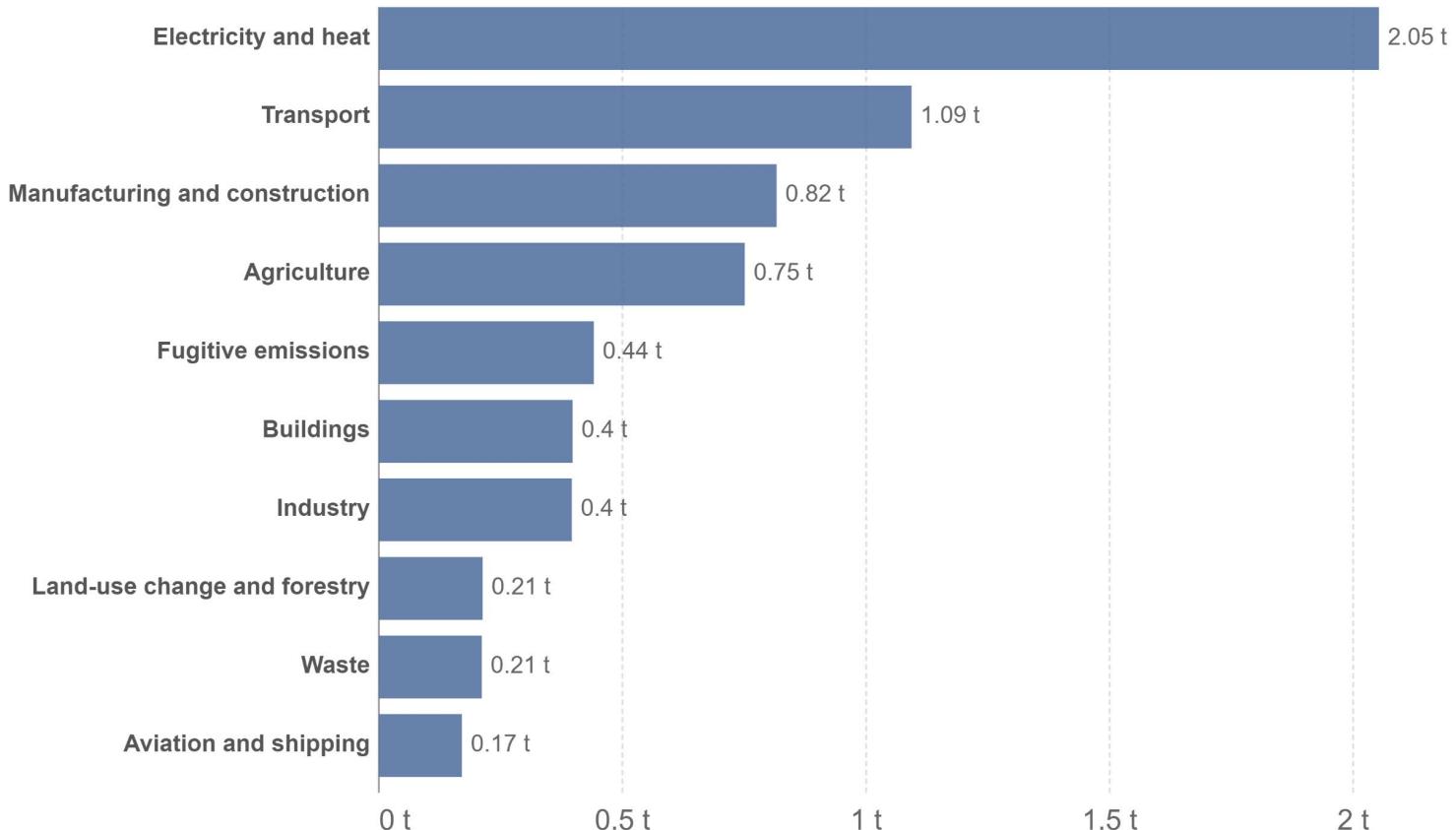
Licensed under CC-BY by the author Hannah Ritchie (2020).

Hvor kommer klimagassen ifra?

Per capita greenhouse gas emissions by sector, World, 2019

Per capita greenhouse gas emissions¹are measured in tonnes of carbon dioxide-equivalents²per person per year.

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Source: Our World in Data based on Climate Analysis Indicators Tool (CAIT).

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Sterk korrelasjon
mellan BNP per
innbygger og
utslipp av CO₂

Må vi akseptere lavere
økonomisk velstand for å
minke utslippene av CO₂?

CO₂ emissions per capita vs GDP per capita, 2018

This measures CO₂ emissions from fossil fuels and industry¹only – land use change is not included.

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Source: Our World in Data based on the Global Carbon Project; Maddison Project Database 2020 (Bolt and van Zanden, 2020)

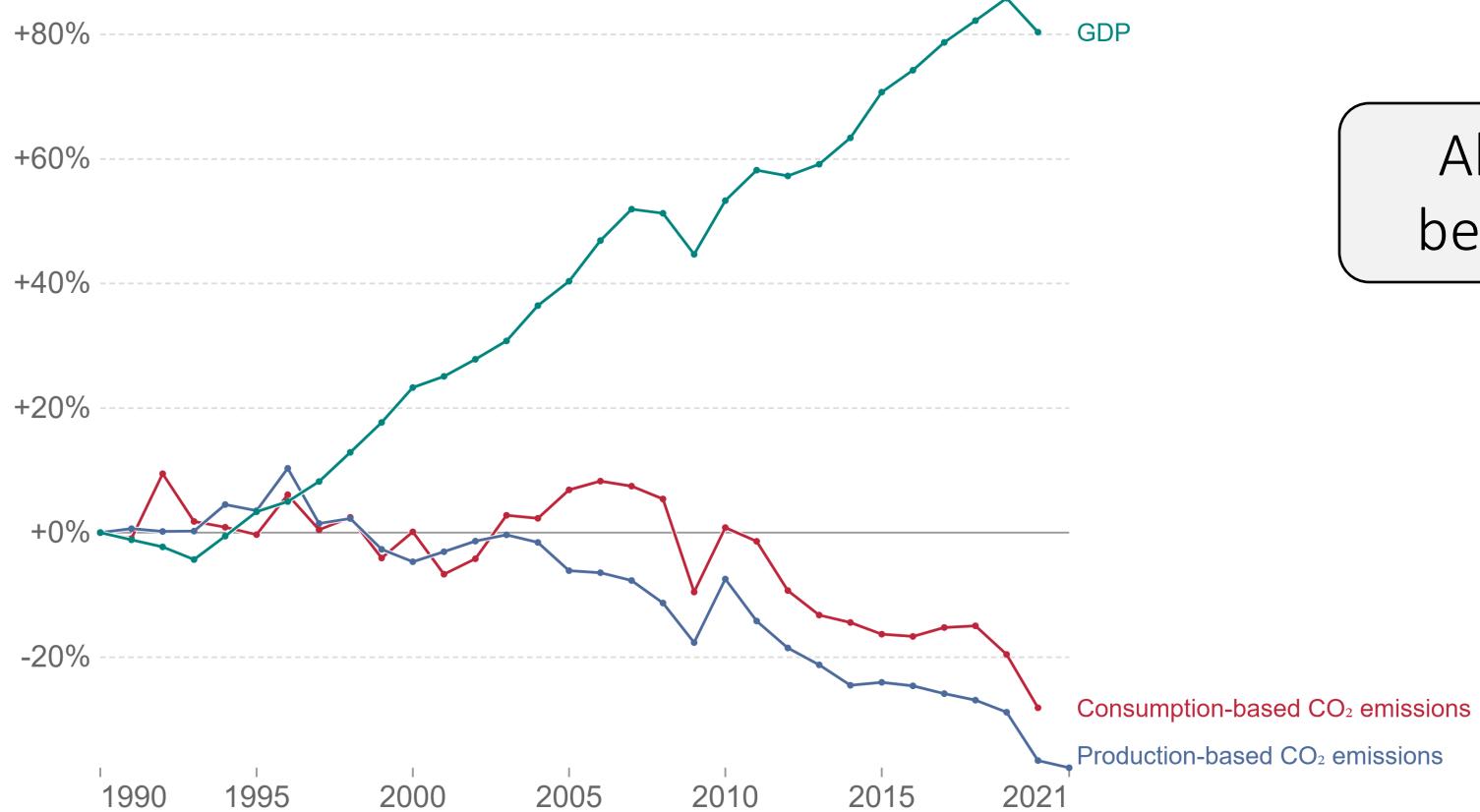
Note: GDP figures are adjusted for inflation.

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Change in CO₂ emissions and GDP, Sweden

Consumption-based emissions¹ are national emissions that have been adjusted for trade. This measures fossil fuel and industry emissions². Land use change is not included.

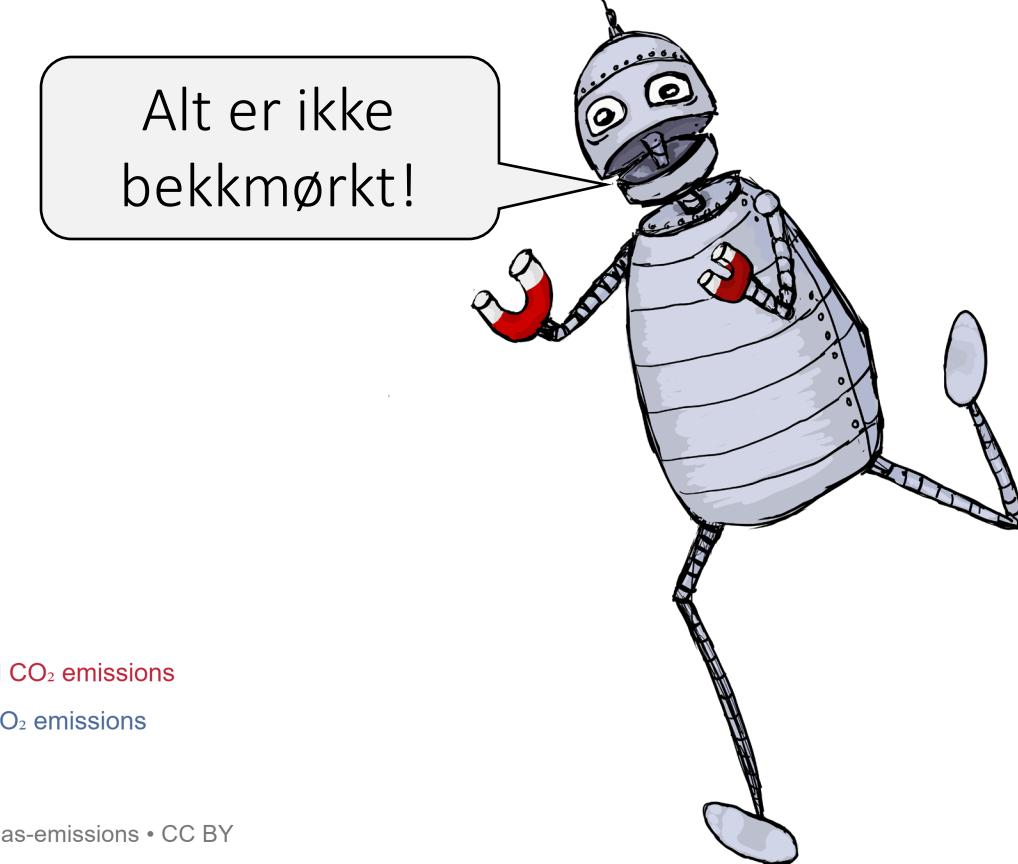
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Source: Global Carbon Project; World Bank

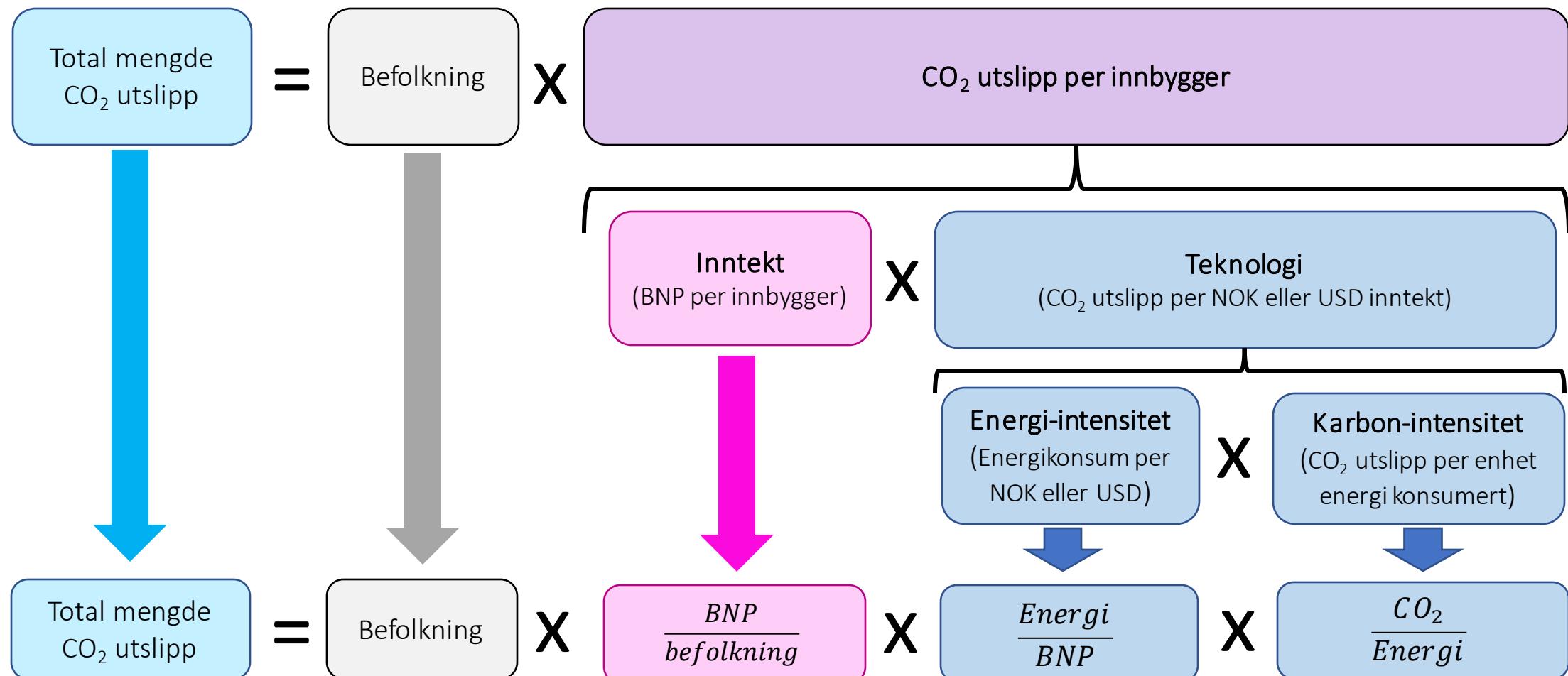
Note: Gross Domestic Product (GDP) figures are adjusted for inflation.

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Hva bestemmer de totale nivået på CO₂-utslipp?

Kaya-identiteten

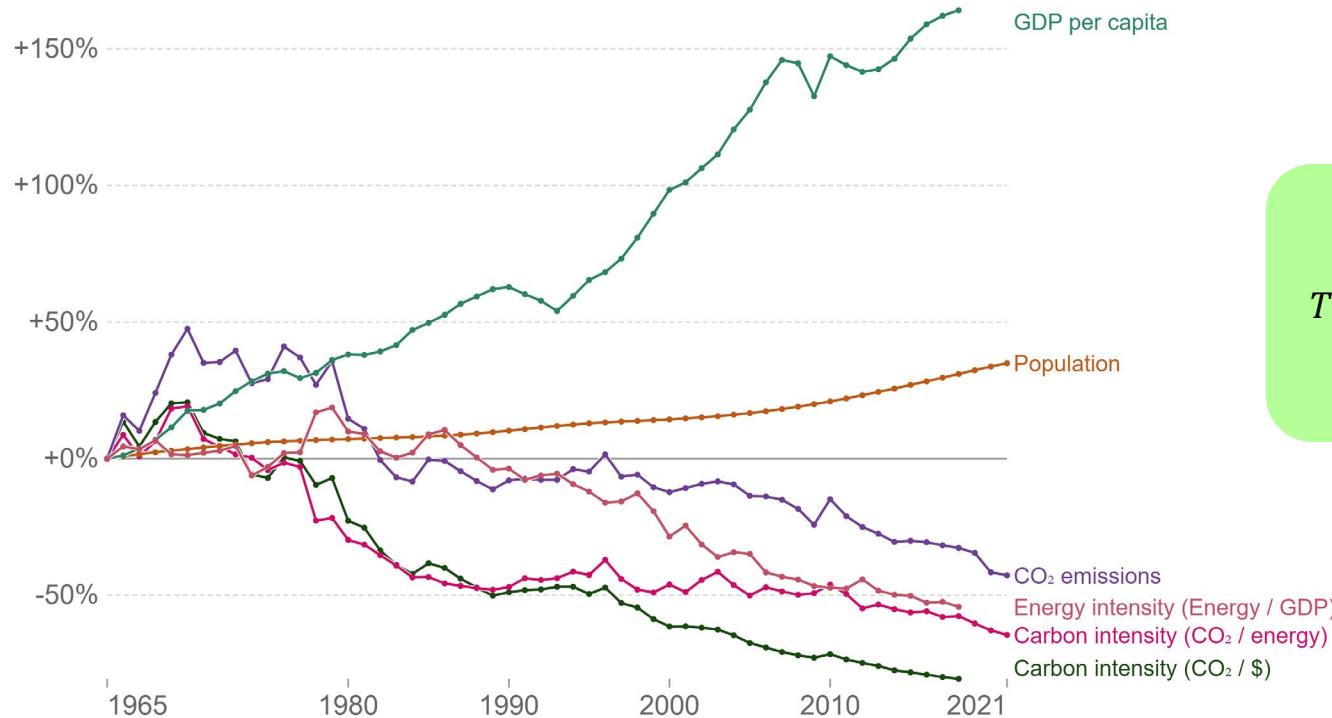


Hva bestemmer de totale nivået på CO₂-utslipp?

Kaya identity: drivers of CO₂ emissions, Sweden

Percentage change in the four parameters of the Kaya Identity, which determine total CO₂ emissions. Emissions include fossil fuel and industry emissions¹. Land use change is not included.

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$$\text{Total CO}_2 = \text{Befolknings} \cdot \frac{\text{BNP}}{\text{Befolknings}} \cdot \frac{\text{Energi}}{\text{BNP}} \cdot \frac{\text{CO}_2}{\text{Energi}}$$

Source: Our World in Data based on Global Carbon Project; UN; BP; World Bank; Maddison Project Database

Note: GDP per capita is measured in 2011 international-\$ (PPP). This adjusts for inflation and cross-country price differences.

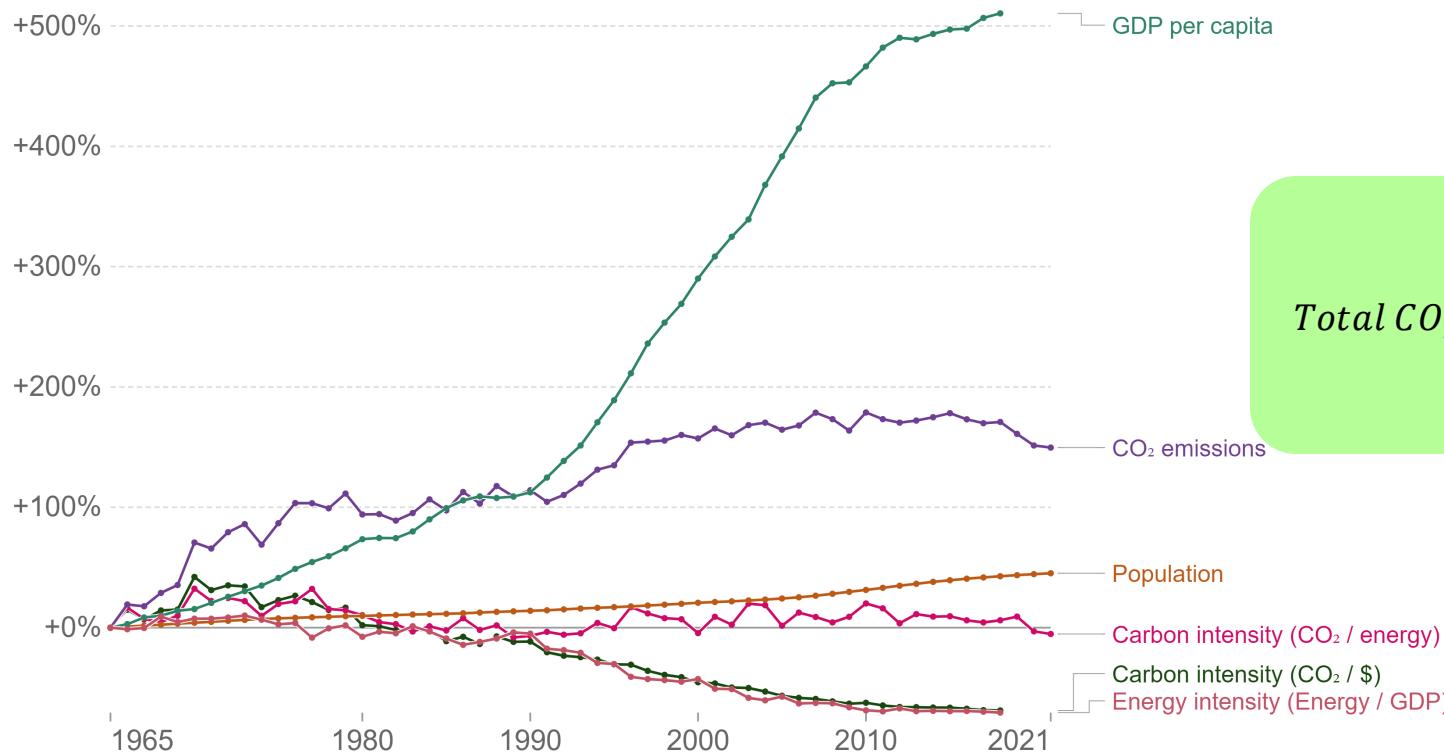
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Hva bestemmer de totale nivået på CO₂-utslipp?

Kaya identity: drivers of CO₂ emissions, Norway

Percentage change in the four parameters of the Kaya Identity, which determine total CO₂ emissions. Emissions include fossil fuel and industry emissions¹. Land use change is not included.

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in Data



$$\text{Total CO}_2 = \text{Befolkning} \cdot \frac{\text{BNP}}{\text{Befolkning}} \cdot \frac{\text{Energi}}{\text{BNP}} \cdot \frac{\text{CO}_2}{\text{Energi}}$$

Source: Our World in Data based on Global Carbon Project; UN; BP; World Bank; Maddison Project Database

Note: GDP per capita is measured in 2011 international-\$ (PPP). This adjusts for inflation and cross-country price differences.

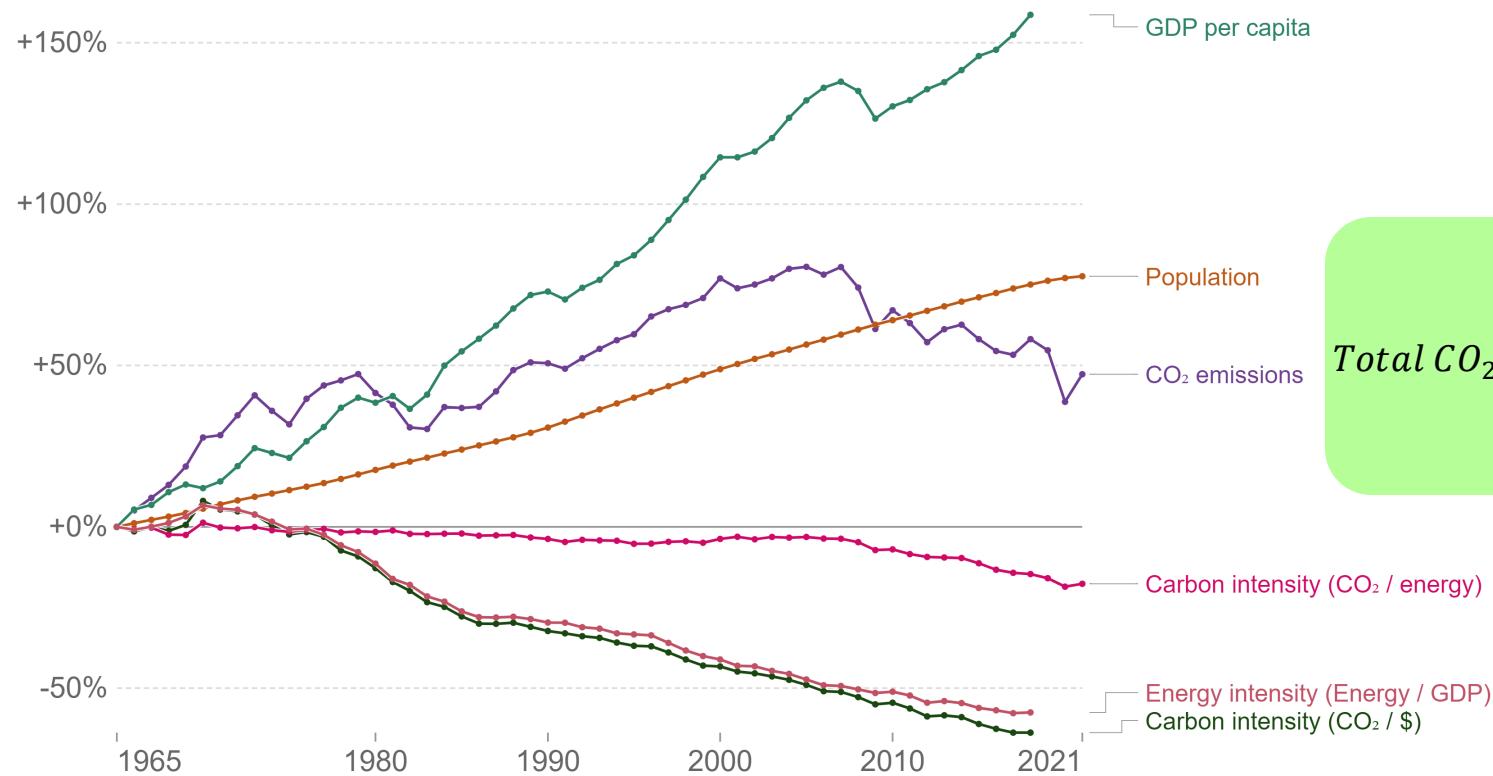
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Hva bestemmer de totale nivået på CO₂-utslipp?

Kaya identity: drivers of CO₂ emissions, United States

Percentage change in the four parameters of the Kaya Identity, which determine total CO₂ emissions. Emissions include fossil fuel and industry emissions¹. Land use change is not included.

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in Data



$$\text{Total CO}_2 = \text{Befolknings} \cdot \frac{\text{BNP}}{\text{Befolknings}} \cdot \frac{\text{Energi}}{\text{BNP}} \cdot \frac{\text{CO}_2}{\text{Energi}}$$

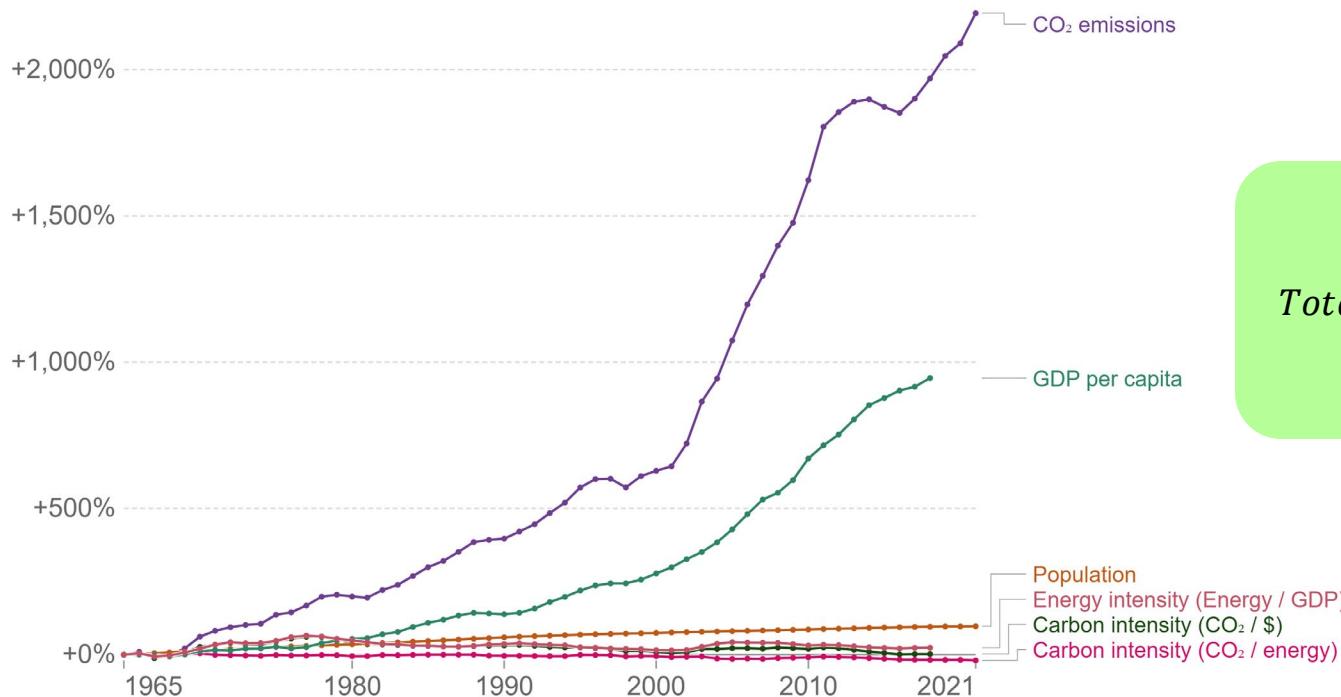
Source: Our World in Data based on Global Carbon Project; UN; BP; World Bank; Maddison Project Database
Note: GDP per capita is measured in 2011 international-\$ (PPP). This adjusts for inflation and cross-country price differences.
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Hva bestemmer de totale nivået på CO₂-utslipp?

Kaya identity: drivers of CO₂ emissions, China

Percentage change in the four parameters of the Kaya Identity, which determine total CO₂ emissions. Emissions include fossil fuel and industry emissions¹. Land use change is not included.

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in Data



$$\text{Total CO}_2 = \text{Befolknings} \cdot \frac{\text{BNP}}{\text{Befolknings}} \cdot \frac{\text{Energi}}{\text{BNP}} \cdot \frac{\text{CO}_2}{\text{Energi}}$$

Source: Our World in Data based on Global Carbon Project; UN; BP; World Bank; Maddison Project Database
Note: GDP per capita is measured in 2011 international-\$ (PPP). This adjusts for inflation and cross-country price differences.
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Who has contributed most to global CO₂ emissions?

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in Data

Cumulative carbon dioxide (CO₂) emissions over the period from 1751 to 2017. Figures are based on production-based emissions which measure CO₂ produced domestically from fossil fuel combustion and cement, and do not correct for emissions embedded in trade (i.e. consumption-based). Emissions from international travel are not included.

North America

457 billion tonnes CO₂
29% global cumulative emissions

USA
399 billion tonnes CO₂
25% global cumulative emissions

Asia

457 billion tonnes CO₂
29% global cumulative emissions

China
200 billion tonnes CO₂
12.7% global cumulative emissions

Japan
62 billion t
4%

EU-28

353 billion tonnes CO₂
22% global cumulative emissions

Russia

101 billion tonnes
6% global emissions

India

48 billion t
3%

South Korea

16 billion t
1%

Taiwan

8 billion t
0.5%

Thailand

7.45 billion t
0.45%

Uzbekistan

6 billion t
0.4%

Saudi Arabia

14 billion t
0.9%

Malaysia

5 billion t
0.32%

Pakistan

4.4 billion t
0.28%

North Korea

5 billion t
0.32%

UAE

4 billion t
0.26%

Iran

17 billion t
1%

Indonesia

12 billion t
0.8%

Iraq

4 billion t
0.26%

Azerbaijan

2.2 billion t
0.14%

Turkmenistan

2.2 billion t
0.14%

Kazakhstan

12 billion t
0.8%

Vietnam

3 billion t
0.2%

Qatar

1.9 billion t
0.13%

Philippines

1.9 billion t
0.13%

Singapore

1.9 billion t
0.13%

Ukraine

19 billion t
1.2%

Turkey

9.6 billion t
0.6%

Algeria

4.1 billion t (0.26%)

Brazil

14.2 billion t
0.9%

Venezuela

7.6 billion t
0.5%

South Africa

19.8 billion t
1.3%

Nigeria

3.4 billion t (0.21%)

Colombia

3.1 billion t (0.2%)

Argentina

8 billion t
0.5%

Australia

17.4 billion t
1.1%

Libya

0.7 billion t (0.04%)

Morocco

0.7 billion t (0.04%)

Chile

0.7 billion t (0.04%)

Peru

0.7 billion t (0.04%)

Egypt

5.6 billion t (0.35%)

Uganda

0.7 billion t (0.04%)

Angola

0.7 billion t (0.04%)

Paraguay

0.7 billion t (0.04%)

Malta

0.7 billion t (0.04%)

Yemen

0.7 billion t (0.04%)

Albania

0.7 billion t (0.04%)

New Zealand

0.7 billion t (0.04%)

Europe

514 billion tonnes CO₂
33% global cumulative emissions

Africa

43 billion tonnes CO₂
3% global emissions

South America

40 billion tonnes CO₂
3% global emissions

Oceania

20 billion tonnes CO₂
1.2% global emissions