By the end of the 21st century,
humanity is becoming desperate.

Decades of heatwaves and droughts
have led to unusually poor harvests,

while the warming oceans yield fewer fish each
year. In the tropical zones, millions suffer from

famine and resource wars have made millions
more flee to the north. As things quickly

get worse, in an act of desperation, the world's
governments decide to enact an emergency plan...

It is far from certain that a grim scenario like
this will play out. But the failure of world

leaders to effectively address climate
change, makes it far from impossible.

So in the near future it might become necessary
to try something radical to slow down rapid

climate change: Geoengineering.
Interventions so massive in scale

that they might undo centuries of human
behavior. Or make everything much worse.

What is geoengineering, is it really
an option and what if it goes wrong?

Geoengineering methods vary from fantastic ones
like constructing giant light sails in space

to seeding clouds with salt or
wilder ones like fertilizing

the oceans with iron to speed up the
growth of trillions of algae cells.

In this video we'll focus on an intervention
we could see during our lifetimes:

Stratospheric aerosol injection. A clunky term

that means spraying stuff very high up
in the atmosphere to keep the sun away.

Keeping the Sun away

CO2 doesn't heat up the planet on its own, almost
all of the energy on earth comes from the sun in

the form of electromagnetic radiation. About 71%
of this energy is absorbed by the earth's surface

and atmosphere. This absorbed energy is
emitted again, as infrared radiation. And

CO2 is able to trap this infrared radiation
and keep it in the atmosphere for a while.

You can compare this effect with
snuggling under a blanket in the morning.

Even in a really cold room, your
body emits infrared radiation

and the air between your body and the blanket
traps it and creates a warm and comfy feeling.

So one way to cool down the planet would
be to prevent energy from getting trapped

under our planet blanket. Which is
already happening naturally. About 29%

of the solar radiation hitting earth
is reflected back to space by bright

surfaces like ice, deserts, snow or clouds.
More reflection, less energy, less warming.

We can look at nature for inspiration:

Specifically the 1991 Mount Pinatubo
eruption, the second largest volcanic

eruption of the 20th century. Aside from
massive devastation and almost 900 dead,

scientists noted its strong impact on the
global climate. The explosion ejected millions

of tons of particles and gas as high as the
stratosphere which hung around there for a while.

The stuff that is interesting for geoengineering
is sulphur dioxide. A nasty smelling and invisible

gas. High in the atmosphere, it produced a haze
of sulfuric acid droplets, that mixed with water

and created giant veils. These veils reduced the
sunlight reaching earth's surface by roughly 1%.

Global average temperatures dropped by 0.5°C.

It took three years until this
cooling effect had stopped.

Humans could imitate this process by injecting
sulfur particles directly into the stratosphere.

According to some scientists, this
might be surprisingly easy to do

and we don't even need a lot of new
technology for it. According to one study,

it also might be pretty cheap compared
with the cost of rapid climate change.

A small fleet of specialized airplanes could
ascend once a year and distribute aerosols along

the equator from where they would be spread around
the world. Projections assume that injecting

between five and eight megatons of material per
year would reflect enough sunlight to slow down

or even stop global warming. . Giving us precious
time to transition away from fossil fuels.

Unfortunately, there might be
a few unhappy side effects.

There are a number of potential
issues with aerosol injections:

rainfall patterns could change which
could negatively affect agriculture

and cause famine. Billions of people
could be affected in the worst case.

Also, after the 1991 Mount Pinatubo eruption, the
acid/water veils not only cooled down the surface,

they also heated up the
stratosphere. As it turns out,

acid is bad for the ozone layer and the
ozone hole over Antarctica was the largest

it ever has been . Injecting sulfur particles
over decades could have a similar effect.

Scientists have already suggested
using a combination of different

minerals that might have much less
harmful effects on the ozone layer

but more research and experiments need
to be done to make sure this could work.

But even if we don’t damage the
ozone layer, there are other risks.

Politicians and industry
might use the cooling effect

as an excuse to delay the switch
to a carbon neutral economy.

Even if geoengineering slows down global
warming, humanity is still adding extra CO2

to the atmosphere. More CO2 in the air means

that the oceans absorb more CO2, which makes

them more acidic. This is already beginning to
be deadly to huge ecosystems like coral reefs.

And the longer this continues, the
more severe the effects will be.

But it gets worse: Once we start pumping
particles into the atmosphere on a massive scale,

we might be forced to do so for a long
time, or we could risk a termination shock.

What that means is that if humanity
continues to enrich the atmosphere with CO2,

but at the same time prevents the planet
from heating up by blocking solar radiation,

we are sitting on a time bomb.

Once we stop geoengineering, the
natural cycle will take over again,

and earth would heat up. But after a few
decades of keeping the planet artificially

cold while still releasing massive amounts of
CO2, it would heat up, much, much quicker. An

increase in temperature that would take 50
years today, could happen in just 10 years.

Such a temperature shock in such
a short time would disrupt every

major system on earth so much that it
would be impossible to adapt in time.

The worst case scenario could be dramatic
famines and the rapid destruction of ecosystems.

Humanity might survive. But the survivors would inhabit an unfamiliar and hostile world.

The best case scenario is that once the world has
finally fully understood the existential danger

of rapid climate change,geoengineering
can buy us a crucial decade or two.

Time to transition our economies
and maybe even pull CO2 out of the

atmosphere. Maybe with technologies
that we'll discuss in a future video.

Conclusion

Geoengineering is a scary concept. It is not a
solution to climate change and it might even be

a welcome excuse for the fossil fuel industry
to delay the end of the fossil fuel age.

Over the last few decades geoengineering has
been so controversial that it stopped many

scientists from doing the experiments
necessary to understand it better.

But blankly opposing
geoengineering is short sighted.

The sad truth is that we are already
running a geoengineering experiment.

We are testing how fast the world changes if
we add about 40 billion tons of CO2 each year.

This experiment is about to get really exciting.

Hopefully we never have to use Geoengineering.
But if we need to in the future,

we better have done the science. We better
be prepared. Or a panicking humanity

might accidentally press the self destruct button.

You probably won't have to do any of that
yourself – but who knows! Better brush up

on your science knowledge, just in case. Our
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