So

welcome to this, our second to last

penultimate lecture, lecture number 19.

So this one is well it's starting

something unusual again. So what do I

mean by that?

After lecture 16 you might have assumed

that we could have just gone on and

continued with the western tradition,

moving forward in the 20th and 21st

centuries.

Well yeah, in fact other classes I

teach I start with just material in that

period,

but I wanted to do something different.

First with what we just had with

Buddhism,

to show that you know it's not only a

western tradition

on this planet, that there's others

as well,

and Buddhism is an interesting one to

think about

for all the reasons that we have

environmentally. But with this lecture-

these two lectures, 19 and 20, I wanted to

do something still different,
and in fact there are three reasons for
doing them.
So first is well we've looked at how
cultural traditions and changes can have
an impact
potentially on the environment. Well what
if we actually began instituting those
big changes, could they make a difference?
And what I'm thinking about here
is with consumerism and, in general,
lifestyle changes, which we've seen back
beginning with Ben
Jonson, in the early modern period, and
sir John Denham,
but especially with Henry David Thoreau,
who's you know asked us to
radically rethink our lives and make
significant changes.
And of course Buddhism does the same
non-attachment and all.
So what if we actually did those kind of
changes? Could it make a big difference
with respect to say the climate crisis?
And why the climate crisis? Well
environmentally it's clearly the biggest

issue we're facing right now and
may well, against all other issues in
the 21st century, be the defining issue
of the century.
And the answer to that is yes, it can
make a significant difference.
Technology and all is important, we
need that to help
with the climate crisis sure, but making
cultural changes can have profound
implications.
So we're going to be taking that up, not
in this lecture, but in number 20.
And so this one-
well the two titles, the climate crisis,
what it is,
that's this lecture. So before we can get
into like solutions and
what we can do about the climate
crisis, we really need to have a better
understanding of it, and I want to make
sure everyone has that, so that's what
this lecture will be.
Apologies, it's a little long, but well
it's a big topic and a lot to cover.
But then in 21, the climate crisis,

what it is,
what each of us can do about it, we'll
talk about how cultural changes can make
a profound difference environmentally
with respect to climate. The second
reason I wanted to do these lectures,
these two at the end, is because
well I think everyone should know this
material.
And I don't just mean everyone at UCSB,
or even in the UC system, or for that
matter even in the United States, I mean
everyone on the planet should have a
good understanding of what's happening
with the climate crisis,
and what we can do about it. So since I
have you in the class I thought I would
leave you with that.
And the third reason is that, as I
mentioned a few times, I teach a
companion course of this, English 23,
and the title of that course is the
climate crisis, what it is, and what each
of us can do about it.
So this is a condensed version of that
course in a way. If you're interested in

that course, what it's about, well here
you're going to
get a brief kind of overview of it,
not so much with today's lecture, but
with the one coming up, number 20.
And you know if you decide to take that
course, or you've already decided,
when you start, you're going to basically
start with this material again,
but in more detail, and then we're going
to go into
a lot more of what we can do about the
climate crisis, after we explored the
problem a little more too.
So anyhow, those are the three reasons,
and I hope you
enjoy these. Today, by the way, when you
leave this lecture,
you're not gonna feel particularly
optimistic because I'm gonna lay out a
lot of problems,
but hold on before you get too
depressed, or if you are,
immediately open up number 20 because 20
again is what we can do about this, and
we can do a lot about it. We can

seriously mitigate this problem if we

all jump into it right now.

But for us now, let's jump into our

prezi.

And here we are, look at how much ground

we've covered, look at how many lectures

we've covered.

Number 19. Popping into focus.

The climate crisis, what it is.

And now whoops- now we are going to jump

into

a little poll here. Do you believe in

anthropogenic climate change? You know I

ask this every year

in this course, and I get different

responses. Not everyone in the class, you

might be surprised,

believes in it. Anthropogenic

of course,

another one of those words like

anthropocentric and anthropomorphic,

anthropo meaning human, but here

genus means

in Latin- in Greek rather the

the emergence of, you know caused by,

like the word generation comes from that. So do you believe the climate crisis is-

climate change is being caused by human

beings? First you have to

see if you actually believe in it that

it’s happening, not everyone in the US

does, and second then that human beings

are the principal cause of it.

The answer to that is it is true and it

is happening, but let's

get into detail about all that.

Where does wood come from?

Who else, but me I guess, would start this

lecture this way.

I mentioned you know for a couple

decades of my life I made my living as a

furniture maker,

and I have a special connection to wood

as you might imagine, I think it's a

wonderful material with

incredible potential. So I guess I'll

start it with a discussion of wood,

but I think you'll see right away

this actually

is relevant. So. What I mean by that

question, if you plant a tiny acorn right,

and you know an acorn right it's like

a little thing, it's the size of a grape

or weighs under an ounce.

If you wait long enough, you wait a

human lifetime,

it'll become an oak tree containing

thousands of pounds of wood, literally

tons and tons of wood.

Where does all that mass come from? How

did it go from under an ounce

to millions- to thousands of pounds of

wood?

It comes from, and I think this is just

coincidentally interesting I guess,

that these correspond to the four

classical Greek elements of

earth, water, air, and fire. I'll tell you right now

that wood comes from all four of these,

but one of them more than any other.

So, let's look at earth. Without certain

elements from the soil, like nitrogen,

plants cannot survive, so it definitely

gets material-

minerals from the soil. That's why, by

the way with respect to fertilizer,

you know I grew up on a farm,

how does that work? Well if you use

chemical fertilizers you can put
nitrogen directly
into this soil by spreading fertilizer on
the ground.
Organic farmers don't do that, they- on
the one hand
use compost, but interestingly on the
other hand, they use things like
plants, like legumes, beans, and pulses,
things like that, because certain plants
can actually put nitrogen back into the
soil. They have roots that go, like beans,
roots that go
deep into the ground, and they- we call it
fixed nitrogen, that just means put
nitrogen in the soil. So
you definitely need minerals. You
definitely need water,
that's why you know during a drought, so
many plants die. And the reason they die
by the way,
some like grass, like turf grass, you know
lawns, you know the roots only go into
the ground like
three or four inches, not very far, you
have to water them like

maybe every day, every other day. But
other things like sages, and I'm actually
looking at some sages,
salvias, here in my garden, they have
roots that go into the ground like six
or eight feet, and they're also well
positioned to take the moisture out of
the air in the morning- like on a
morning like today here in Santa Barbara
where it's overcast and
we sort of have a lot of fog hanging. So
you definitely need water for plants.
Air too, right. Just like with all animal
life,
you know if you were to take a
plant, a potted plant, you had in your
house, you put it in the plastic bag, you
tie it closed,
that plant will die, it needs air to
survive.
And finally energy. I say fire here,
you know using the Greek element, but I'm
talking about photosynthesis, you know
you need
sunlight, without sunlight plants will
die. That's why if you've ever

seen growers growing, and you see in
California quite a bit. If you go
past a field and you see it's black
plastic all over the field and you wonder
what that's about,
well growers, farmers, will spread that
plastic over the field and make little
holes
to put in something like a strawberry
plant, so the roots can go underneath of
the plastic, but the leaves stay above.
That's an ideal situation because the
little plant gets all the sunlight that
it needs with photosynthesis.
But what that's really there for is, once
you start wandering all sorts of weeds
are going to pop up around that plant
because
the water will go through the plastic at
the little hole,
but those weeds, because they're under
the plastic, even though they'll sprout,
they won't have access to the sun, and
they will die right away. So that plastic
is a form of herbicide really, it's
killing plants, but

it's relatively benign as far as it
doesn't use chemicals.
But on the other hand, you'd have to
produce all that plastic, which is
principally done through chemicals
from the fossil fuel industry. Anyhow,
here's the poll.
Where does most of the wood in your
furniture
and houses principally come from? Earth?
Water? Wind? Or fire? The answer is,
drum roll please, sorry I don't actually
have
drum or special effects. But the answer,
which may be surprising, is
"C," out of air, thin air.
Believe it or not those many
tons of wood
in an oak tree come directly out of thin
air.
What they are principally getting out
of air
is carbon, and all life on earth,
plants including and also
human beings and animals, are principally
composed of carbon.

This matters because carbon is the “C” in

CO_2. Also when we say the word

carbohydrate, or we shorten it for carbs,

that's the

carb in carb, carbohydrates is also

carbon. So let me explain this

because CO_2 is very important.

CO_2 is the principal greenhouse gas.

So what's causing the climate crisis

principally?

One gas in the atmosphere, CO_2. There are

others as well, we're going to talk about

today methane for example.

But you know the one that's the most

important is CO_2, and

these gases, we call them more

generally greenhouse gases,

are what's bringing about you know

global warming

and all the climate change

that's happening.

So since Shakespeare's time, CO_2 has been

rising steadily,

about 280 parts per million in his time,

that's 400 years ago,

to rise to about 415 today.

It actually rose from the time I was
born 60 years ago,
like 1959, 1960, it rose from 315 parts
per million to 415. So while it's been
accelerating since Shakespeare's time,
some people call the period after the
second world war the great acceleration
because it's been growing
very quickly since then. But it does
raise the question, where does all that
CO_2
come from? And also note
you know these are relatively small
concentrations of CO_2. So you'll have
sometimes like climate change deniers
say well that's almost irrelevant
right, a few parts per million, what are
we worried about?
Well we should worry about it because a
few parts per million can make a really
big difference,
so we'll see how, but just know
that even though these are small
percentages,
they are significant and significantly
impact the climate.

So plants and animals. So plants rather are capable of doing something altogether extraordinary with atmospheric CO_2 when they combine it with water.

So you know they pull CO_2 out of the atmosphere, they pull water principally out of the ground through their roots, and this gets energized by solar radiation, that's the power source, and a little bit a few minerals like nitrogen all thrown in.

So, in a way, plants are like little factories, their plant bodies are factories. What they do, they are able to take CO_2 and H_2O, you know two molecules, simple molecules, and they are able to synthesize these molecules into a whole range of new molecules. So in that sense they're like little chemical factories.

So sorry I know I am a humanities professor, we're going to have to do a little bit of science with a few formulas here. So let's look at this one.

You take six molecules of CO_2 and six

molecules

of H_2O, they're absorbed by a plant, again

principally you know from the atmosphere

and from

the soil, and they're able to create

something. Six and six of these will

create one molecule

of $C_6H_{12}O_6$, you may know this

more commonly from either chemistry or

high school classes

as glucose. It can be a number of

different molecules, it can be sucrose,

it can be galactose,

they all share the same formula, but the

molecular structure is slightly

different.

But how does this work? Well you take six

molecules

of carbon, they come down here, they're

incorporated, but

let's skip that O_2 for a moment.

Six molecules of H_2, so they’re

two atoms. I'm sorry,

you're taking- here we have two atoms of hydrogen

and H_2O, so six times those two gives you

12 atoms of hydrogen here,

and if you go six times the oxygen atoms

here, you get O_6,

that's what you need to form this

molecule.

You may notice I skipped over six here

and

two atoms of O_2. Well this also becomes,

then through like a byproduct of the

synthesizing of glucose,

released into the atmosphere six

molecules of O_2. O_2,

as you may know, is the oxygen that

we

breathe, O_1 is not what is in the

atmosphere that we take in.

So this is what it does then, for every

six molecules of CO_2 and water,

it produces a molecule of glucose, or a

similar sugar,

and it also produces six molecules of

O_2.

This is an incredibly crucial service

for

all animals. All plants, not all plants

produce

glucose, but all plants do this sort of

synthesizing.

And in the case of plants that produce,

let me get out of here for a moment,

this six molecules of CO_2 are nicely

converted to six molecules of oxygen, you

probably all remember this from high

school, and what a great thing that is

because you know

all animals breathe

oxygen. So this is a wonderful symbiotic

system, a wonderful imbalance system

right.

We exhale oxygen, and you know in a

proportionate amount, plants take in

oxygen and- I'm sorry we exhale CO_2,

and in a proportionate amount, plants

take in CO_2,

and they exhale or put out into the

atmosphere oxygen, which then we inhale

to start the process

over again. Wonderfully balanced perfect

little system.

But we often forget that in addition

to the chemical you know factory that is

a plant's body,

they're also producing fructose, and

glucose, and galactose,

and similar molecules. These molecules

are really essential for us too right

because these are what we know as sugars

or

carbs. So not only do plants give us the

air that we breathe essential for

our life, they give us the food that we

eat in the form of sugars, of carbs.

Incidentally, and I mentioned at the

beginning, but just to break it down here,

the word carbohydrate, hydrate

here it comes from water, it comes from

the Greek as well,

and you know carb is carbon. So what are

carbohydrates? They are hydrates of

carbon. So remember we had six molecules

of carbon and six of CO_2,

well the water CO_2 is providing the

water

and the co- I'm sorry the H_2O is

providing the water and the CO_2 is

providing the carbon,

and then you have carbohydrates. So
whenever you talk about that,
or when you shorten it and just say
carbs, you're really talking about
carbon here, and you're talking about
carbon that one way or another came out
of the atmosphere,
came out of thin air. So not only does
wood come out of thin air,
so does most of the food that we eat,
almost all the food that we eat either
directly or indirectly,
which is again pretty amazing and don't
we love plants.
You know sometimes you've heard in
science fiction shows,
life on earth referred to as carbon
based life. There's a
tv series called ‘Altered Carbon’ about
altering the dna of human beings,
acknowledging that we're just carbon,
it's an acknowledgement that the body
is, of all plants, and all animals, is
principally carbon.
The human body is 65% oxygen, 18%
carbon, and then almost 10% hydrogen.

But what happens in world the carbon

shows itself

is, if you dry out a human being, which

people have been doing for thousands of

years with mummies, you know all the

water will leave, and a lot

the oxygen will

go back up into the atmosphere again, and

what's principally left is carbon.

Most of our world has been made out of

carbon,

really out of thin air. So when you talk

about natural materials, especially-

synthetic materials too

made out of things like petroleum oil

into things, but

here especially with natural materials.

So you know clothing, if you're wearing

cotton linen hemp,

something like that, well that's plant

material, that's all was

you know composed- was constructed in a

plant's body

by taking CO_2 out of the atmosphere.

But even if you have animal products

that you wear things like leather, wool,

silk, well those have been synthesized in
the bodies of cows, and of sheep, and of
silkworms,
to become those materials. Food of course
you know it's the things that you
directly eat, you know plants and
vegetables,
which are you know directly glucose.
But also you know something like a cow
is able to take that material in, and
then
you know by way of something like grass
or soy beans, and create
milk and meat that we eat, and so
it's also coming from thin air, from CO_2,
although indirectly.
And of course back to my starting
example of wood,
so much of you know traditional house.
You know today we have modern houses
that have like
aluminum and vinyl siding and all,
traditional house had a wood frame,
wood on the outside, wood you know like
cedar shingles and so forth. So
suffice it to say that a big part of our

world,
both where we live, what we wear, what we
eat,
if you use natural materials, it comes
out of thin air.
But then we need to talk about fossil
fuels, which we’re getting into our climate
change discussion here. Just so that you
know,
in addition to being able to synthesize
sugars like glucose,
plants can create other molecules. And
when we're talking about wood, we're
talking about things like cellulose,
hemicellulose, and lignin,
these are other molecules. And you can
see cellulose here
looks very similar to glucose insofar as
it's carbon hydrogen oxygen,
same exact thing if you remember
that formula, but a little different here,
and the molecule is obviously going to
be a-
take like a different shape too, but all
kinds of molecules can be created.
So when a plant dies and decays,

the carbon that it contains right, and

it's principally can store

carbon, doesn't matter whether we're

talking about glucose, or lignin, or

whatever,

it generally as the plant decays will

recombine with oxygen and again become

atmospheric CO_2

right. So this is a continual process, a

plant absorbs CO_2 out of the atmosphere,

one way or another you know once it dies,

even after an animal has eaten, it doesn't

really matter, one way or another

even after the animal dies, one way or

another, that

carbon is going to get back into

the atmosphere

if this you know plant or even

animal decays,

and they'll combine with atmospheric CO_2,

and the carbon

oxygen will become CO_2. So that

is generally what happens. And you

can see this, you know every spring this

happens,

when you know plants spring up with new

growth, that's where the word spring
comes from,
they pull CO_2 out of the atmosphere,
and that's where all that new growth
comes from. So if you're
in a place where it's really cold, like
I'm from back east and in the winters
there aren't a lot of green plants, and
then suddenly there's an explosion of
green plants starting in the spring and
really in the summer.
What's all that greenery about? That's
all carbon,
all around you, and it's been pulled out
of the atmosphere. So
at that point of the year, you know
summer especially when you have all that
greenery finally and finally full grown,
there's a little less carbon in the
atmosphere, a little less CO_2 than there
would be.
But every fall when all those leaves and
all fall,
that's where the word fall comes from,
and start decaying,
then that- the carbon is going back in

the atmosphere.

In fact back east in the fall, people

like to

to drive around to different places

where the leaves are changing, we call

it peaking. So you go to

a place in like Massachusetts where the

leaves are all changing, and they’re

all different colors, and it's beautiful,

and it is, but

what you're really looking at there are

leaves that are in the process of

decaying,

and they're releasing their CO_2 into the-

releasing their carbon back into the

atmosphere. So

as you're driving around and seeing all

that, you're really seeing massive

amounts of CO_2 entering the atmosphere,

but that's okay

because it will get pulled back in again

next spring.

And as a consequence, if you follow that,

CO_2 levels will go down in the summer,

atmospheric CO_2, just by a little

planetary-wise, and then in the winter

they will go back up again
a little since it's been released. If you
think about that for a moment, that
might sound like it shouldn't happen
right because
when it's winter in the northern
hemisphere, it's summer in the southern
hemisphere, and the two you think would
balance out,
and they would except, in fact not
everyone knows,
68% of the land mass of our
planet is in fact in the northern
hemisphere, so the northern hemisphere
sort of wins the day here.
But under certain circumstances,
plant matter does not decay in the above
way,
which is we call aerobic decomposition,
which means just in the presence
of oxygen, so you need oxygen to combine
with the carbon to make CO_2,
two atoms of carbon, one of oxygen. It's
pretty rare today on a planetary level,
but if you go back a few hundred million
years ago, about like a half a billion

years ago,

the planet was much wetter. And what I

mean by that is

the ice didn't exist because it was a

warmer planet,

and as a consequence, you know lots of

areas of

land were sort of marshy areas covered

by a lot of water,

but plants still grew there. And what

happens under those conditions,

if a plant drops in the water, it cannot

decay

because there's no oxygen to combine- to

get that carbon out of there.

So.

When a plant falls underwater right,

aerobic decomposition

stops. Why? There's there's no oxygen,

so the carbon can't recombine with

oxygen to become

CO_2, it just stays there, under water.

If the conditions are right, and again, a

few hundred million years ago they were

right across a lot of the planet, CO_2

then doesn't get released back into the

atmosphere because the carbon just stays

there,

and sequestered underwater, and under the

right conditions,

it gets sequestered underground.

Sequestered I mean just stored,

because the CO_2 can't- the carbon

can't get

out to combine with oxygen to aerobic

decomposition.

A few hundred million years ago you know

the conditions are just right,

and material became fossilized. So-

sorry let me pull this down a little.

What I mean by that is, you know so

imagine the plants keep falling

every year, and since they're not

decomposing, they're just

sitting there on the bottom of your lake

or whatever,

but after you know one year another

group of plants fall, another group of

plants fall, and

ultimately a lot of pressure would be

pushing down on those plants,

and they would begin to get pushed into

the soil. So
again, we're talking a period of millions
of years they would get pushed down further,
and further, and further,
into the soil, and be ultimately
underground.
But they will change though, not through
aerobic decomposition,
but ultimately they become fossilized,
and when they become fossilized
those molecules, whether it's glucose, or
lignin, or hemicellulose, or whatever,
will change. So recall here
our formula for glucose,
the main thing to note here is the
carbon hydrogen
oxygen, and remember it doesn't matter if
this is lignin or
cellulose and all, it has those same
three things.
Different number of molecules for each
of those things- molecules that the
plants-
different number of atoms for each of
those molecules that are synthesized by
the plants, but

still carbon hydrogen oxygen. Well as all
this material
becomes fossilized, it still contains
for the most part carbon hydrogen and
oxygen,
but the number of molecules changes-
(keeps saying) number of atoms changes as
it forms new molecules.
The simplest one is methane, we call this
by the way natural gas, you know it if
you go-
you have a gas stove at home, you turn on
the gas, that blue fame
burning, that's methane burning. In this
case it's the simplest one, and it is a
gas,
you just get one molecule of carbon and
four
of hydrogen. But recall that hydrogen
being the
you know the lightest element means that
this will be lighter than air, and then
this will fly way up in the air if you
release it. Moving from a gas to a
liquid form,
if you take, and this number varies here,

I have n,

but it could be like say 20. So if you

had 20 molecules- 20 atoms of carbon,

and then twice that many, 40 atoms of

hydrogen

and two of oxygen, that's one of the

formulas for petroleum oil, and that's

you know as you know refined into like

the gasoline you have in your car, or jet

fuel and airplanes and all.

So moving from liquid form to a solid

form,

if you have a ton of carbon, and some

hydrogen

and oxygen, you get coal. This is the

particular

formula for anthracite, which is the most

energy dense coal and

kind of in the end game here of

fossilization, the one that

it's ultimately the most condensed. So

same basic thing here is happening,

except

you know the plants were able to take

CO_2 out of the atmosphere and synthesize

all those

molecules. Well those molecules,

by way of heat and pressure and time, get

resynthesized

into these forms of what we call fossil

fuel,

and they can take again a

gaseous liquid or a solid form. Note also

that

they can pick up here like a molecule of

nitrogen, a molecule

of sulfur. This matters because when you

burn

either gasoline or coal,

that has say sulfur in it,

then that sulfur goes up into the

atmosphere

and combines with oxygen, not to create

CO_2, but

SO_2, which is sulfur dioxide.

Sulfur dioxide is a problem because if

you inhale it it's very dangerous for

human beings,

and up until the 1970s, the late 1970s,

cars emitted a little bit of sulfur when

they were burned, and

that is the principal cause of smog. So

if you've seen pictures like of LA in

the 60s and all,

that big issue, that's principally smog,

which should tell you something because

a lot more CO_2 is

released when those cars were

running, but you don't see the CO_2 and

it's

benign in the sense it's not poisonous,

but sulfer dioxide is. And it has another

problem,

when it goes up into the atmosphere, it

can combine with water and come back as

a very dilute form of sulfuric acid,

rain down as sulfuric acid, otherwise

known as acid rain, and that can be very

damaging to plants and

everything. Since the 1970s we've

installed catalytic converters on our

cars to,

unfortunately- or it's good, they can

convert

for example sulfur dioxide, but they

convert it into carbon dioxide,

which is okay because it's better than

the smog I guess, but it does then

contribute just a little more to climate
change.
And power plants are able to, like
coal-fired power plants, have something
called scrubbers on, which can pull the
sulfur
out. But anyhow, this is sort of the end
game
if you know that carbon dioxide pulled
out of the atmosphere
is stored by plants and fossilized, this
is what you get.
And this is a good thing right because
it's safely underground,
those things, and have been for millions
of years, not causing any problems or
changes to the climate. But
let's talk about a greenhouse gases,
these
gases as greenhouse gases, and how they-
how the greenhouse effect works more
generally first. And this is
something you know right, if you leave a
car
you know with your windows up, even on a
relatively

comfortable day like 75 degrees, within

30 minutes the temperature in the car is

going to rise to 109 degrees, which I

note here is why you should never ever

leave pets or children in a car with

close windows,

even on a mild sunny day. But that's how

a greenhouse works,

your car is acting as sort of a little

informal greenhouse at that moment.

And what is it doing? It's taking solar

energy, and trapping it,

and holding it in there.

When we talk about the greenhouse effect,

and this is what's behind

climate change, we're referencing how the

earth's atmosphere,

and certain gases in particular, allow

solar radiation to heat our planet in a

consistent way.

So if you take something like a

basketball and you covered it with a

coat of lacquer, which is very very thin,

being a furniture maker I can

attest to this being true,

that would be much thicker than the how

big the atmosphere is on the earth. So if

you're actually looking at the earth in

space,

it's a tiny tiny tiny little layer, and

this nonetheless is a good thing because

it keeps the planet

warm. People have suggested that maybe

the greenhouse

metaphor here isn't the best one, maybe a

better way of looking at it is to think

of the atmosphere like a little blanket

on the planet,

keeping us just the right temperature.

And it's good because the planet

would be you know- without an atmosphere

it'd be like the moon, would be like

radically too hot or too cold, and they

would go

to extreme temperature variations, but

even that thin tiny little layer of

atmosphere

is what makes the earth habitable. So the

atmosphere is great, it's not only the

air that we breathe, which is the thing

that we think about with the atmosphere,

but you may not realize it's what's

keeping the planet,

temperature wise, habitable, and it's

what's moderating and controlling the

temperature of the planet.

Methane, CO_2, and other gases, and CO_2

again being the big one, but methane

which we're going to talk about, and

remember we just had that as CH_4

as a fossilized form of plant material.

They all contribute to the greenhouse

effect.

This is not a bad thing right, again the

earth would be too cold without the

greenhouse gases,

but we've been pumping greenhouse gases

into the atmosphere

for- in a big way for 400 years, in a huge

way for the last 60 years,

so our planet is warming too quickly. So

again,

think of it maybe not as a greenhouse

effect, but as a blanket effect,

what we've been doing is sort of putting

more and more blankets on the planet

in the last you know- especially

the last few decades,

and as a consequence it's getting hotter
and hotter,
it’s getting uncomfortably hot. And by
the way this is already happening, I'll
talk about that.
So you know
you see the problem, these gases, and
again very small percentage in the
atmosphere,
but nonetheless keep this blanket effect
getting
worse and worse and worse, so it's
getting uncomfortably warm at this point.
By the way, we initially referred to the
impact of all this as global warming,
even before that, scientists like in th
1960s and 70s and the 80s called it the
greenhouse effect, and we didn't know
about it back then, by the way we've
known about it for 150 years.
But in the beginning, like the late 80s
into the
90s and then forward, we started
calling it global warming,
and that was an acknowledgement, like the
fact that we're packing all these

blankets on the planet, that the planet
was getting hotter and hotter.
But when we realized that it was not
going to just-
this warming was not just going to
impact the planet getting warmer,
but it was going to change weather
events, so we'll talk about this in
detail.
So for example, you know oceans get
warmer, and then that
heat from the ocean is able to fuel
hurricanes, which get more and more
severe,
or it changes weather patterns so we
have like a protracted
drought, which we had here in California
up to a couple years ago,
and that can then lead to wildfires
because you know
the plants are all dried out without
rain.
You know all those things are caused by
this. So
we started talking more generally, this
is about 10 years or so about this,

by calling it climate change, and that

was a

an acknowledgement that more was going

to change than just the global

temperature,

that these other atmospheric events were

going to be taking place

and change the climate more

generally.

The last two years or so, and this is

largely because of people like Greta

Thunder,

we've changed the name once again to the

climate crisis, which is of course the

title of this class,

and that's an acknowledgement that you

know not only were things

changing, but it was happening at a

crisis rate already, and

it was a huge crisis would unfold

if we didn't act on this immediately.

So all these things, the greenhouse

effect, global warming, climate change, and

the climate crisis, refer to the same

things, but they acknowledge a

different kind of understanding and a

different way of framing it that's
emerged over
the decades.
It used to be the case that
people would come up to me knowing I
work on
climate crisis and ask me you know when
is climate change going to take place,
that's a misguided question because
it's already happening, it's been
happening my entire life and long before.
Since 1880, the global temperature has
risen about 1.8 degrees
fahrenheit. So when is the planet gonna
start warming? When is global warming
going to happen?
Yeah, the answer to that is 140 years ago.
And not only is the planet warming, but
going back to the way we think of this
as climate change because of all the
other things that happen,
we now have extreme weather events and
all. So there was
a hurricane that recently hit the
Bahamas and it was so severe,
hurricanes are normally measured by

category, it's a scale we have, so

category one through five.

If you were to actually continue

that scale, and stop

five, and put something after, a category

six,

to acknowledge that something was bigger,

and we never had to do that because

hurricanes generally were never that big,

but the hurricane that just hit the

Bahamas would have been a category six

hurricane.

So these things now, that hurricane that

hit the Bahamas,

are being exacerbated by climate change.

Lemme be very clear,

because people like deny it and say well

hurricanes have always happened,

true, but hurricanes they're happening

more often now than they have before, and

the severity of hurricanes like that is

growing,

that's a result of climate change.

Climate change

is not a hypothetical anymore, it's here,

it's now,

it's here in a big way, it's killing
people, and causing people to migrate by
the millions already.
So go back to our four
formulas here again. If you take
any of these, and if you burn natural gas
or oil and
coal, and they all will burn, coal's a
little harder to start burning, but-
and oil's hard to start burning, but if
you reprocess it into gasoline, it'll
burn right away.
But any event, if you burn any of these,
you will release this carbon back into
the atmosphere,
that will then recombine with
oxygen to become
CO_2. But in the process, you know what
we're doing here, is we're digging down
deep in the earth to all this carbon
that's been safely put away for millions
of years,
we're taking it out and allowing it to
combine with oxygen to become CO_2 again.
And this is what's causing,
again the principal cause, this

particular gas, of the climate crisis,

the fact that we're burning all that CO_2,

burning all that

fossil fuels that is adding to CO_2 in

the atmosphere.

Climate change is impacting

everything on life and every place on

the planet. So

in terms of the atmosphere, you know

carbon dioxide is way up in the

atmosphere,

it's at the very tip of the atmosphere,

methane is certainly there as well,

and of course everywhere on earth it's

here with all that CO_2.

And two, it's at the very depths of the

ocean floor

because CO_2 has been absorbed by the

oceans, we're going to talk about this

in a moment, and it's increased the

temperature-

global warming has increased the

temperature of the ocean, they'll talk

about how,

and has also brought CO_2 into the oceans

to make them more acidity,

they raise the acidity and create

a dangerous situation for some animals.

So what I want to do in the next part of

the lecture is talk about

the impact that all this is having, and

let's start with plants and animals.

So the earth has experienced five major

extinction events,

you may be most familiar with the one

that happened

65 66 million years ago, which is of

course the jurassic event

that killed off the dinosaurs. Everyone

knows probably a meteor hit the planet,

caused a cascading climate event that

then meant that you know

75% of the life on the planet, including

all the dinosaurs, died off.

While that's interesting in its own

right, there's an even more

interesting one from our perspective.

So the one that came number three, which

is the Permian-Triassic

extinction event, was caused by some sort

of volcanic eruption,

maybe a huge volcano. Again, this is a

quarter of a billion years ago, the

planet was different than it is,

maybe multiple volcanoes. But whatever

cause of it was,

it released incredible amount of CO_2

into the atmosphere

very quickly, that then caused the

temperature of the planet to rise by

about five degrees celsius.

But not five degrees fahrenheit, five

degrees celsius, much more,

initiated a cascade of events, and we had

more methane coming into the atmosphere

and all.

But the important thing to realize is a

quarter of a billion years ago

a lot of CO_2 got put into the atmosphere,

the temperature rose

very quickly.

During that extinction event, 97%

of all life on the planet as plants and

animals, 97%

died. In comparison again, during the

jurassic event that killed the dinosaurs,

you know just 75% died, still obviously

horrible, but

you know the scope of it here, it's 97%
in the Permian-Triassic event. Why that
matters to
us is, estimates suggest that we're
currently adding CO_2 to the atmosphere
at least 10 times faster than the
Permian
Triassic extinction event. And although,
you know there are hopes that we can
hold temperature rise to like two
degrees celsius, I mean we're already one
degree there, that's what's reflected in
that 1.8 degree fahrenheit number.
We're already one degree there, and the
hope is we could hold it like a two,
and a lot of people are thinking that's
probably not going to happen.
And there are scientists, and people
in general, are talking about what if we
do have a five degree rise like we had
during the Permian-Triassic event.
There's an interesting book by David
Wallace Wells called ‘The Uninhabitable
Earth’ that came out a couple years ago,
there's a large article he wrote before
it, which you can get for free,

where he talks about this: what would the
implications be?
Scientists you know, and people
like Wallace Wells, can speculate on what
it might be,
but you know we do have this example of
what happened before,
a long time ago, but nonetheless when
there was a radical you know change to
the planet's climate,
it happened quickly, and it's
happening more quickly now.
And the result is sobering because
again
97% of all life on the planet was killed
off.
Yeah. Because of what's happening
right now, we have mass extinction event
already happening. So again, it's like the
question you know when is the climate
crisis going to start?
Don't worry, you know it started, it
started 140 years ago.
When is the- Is there a new extinction
event happening?
Yes, it's been happening for a long

time now,

hundreds of years really, you'd even

argue thousands of years, but certainly

in recent decades it's been increasing

dramatically. There's another book you

might find interesting called

‘The Sixth Extinction’ by Elizabeth Kolbert, it's

a very readable book, I

have students read it- read portions of

it in other classes.

And it argues, and

Kolbert is not arguing it herself,

she's you know journalists, but she

interviews lots of scientists

who are of the opinion that we are in

the sixth extinction event.

So you know there's the Triassic Permian

one, then there

most recently there was the

jurassic event, and now,

65 million years later, we have this new

one,

which is the sixth extinction. And this

one is not being caused by

a meteor hitting the earth, it's not

being caused by

a volcano erupting, it's being caused by
human beings,
we are the ones bringing about the sixth
extinction.
And how is that happening? Well the
UN notes that you know every day
150 species are being lost on the planet.
If you do the math,
that's over 50,000 species per year are
being lost, which is an incredible amount.
And people will argue, like climate
change deniers, well species have always
gone extinct
you know that happens, and then new you
know species emerge, and that's just
part of life. And that's absolutely true, but
as Kolbert notes,
you know the extinction rate is so much
higher than the background normal
extinction rate,
a thousand or maybe even 10,000 times
higher, so
yeah there's just no way for
accounting- you know to account for this
other than to attribute it to
human beings.

Yup. And as disturbing as that
is, and the fact that we're maybe in the
middle of the sixth extinction event is
disturbing,
there's another way to look at it. If
we're not talking about just
animals going extinct, but animals
having their numbers reduced. So let me
give an example,
the American bison buffalo, you know you
may know
probably from you know if you went
through secondary schools in the US,
that there were once huge numbers of
buffalo
in this country, and now their numbers
have been dramatically reduced.
Are they you know an endangered species?
Are they in danger of going extinct?
No, they're not, but the numbers have been
reduced so
dramatically. And why? Because well in
part habitat loss, you know we
we took all their land, and we now graze
our
you know cattle there, and we use it you

know

to grow things like that we feed cows

and we eat ourselves.

So yeah, they're not extinct. Similarly

you know

the northern part of the continent here,

like caribou

reindeer, enormous number originally, but

they've been diminished dramatically too.

So these animals, they're in no

danger really of extinction,

but their numbers have been cut back, as

has so many animals across the planet.

So we'll take a little poll. If you take-

If you had a scale,

and let me do this here. If you had a

scale like this on one side,

so on one side here you take all the

animals

on the planet. And what I mean by that is,

all the wild mammals,

all the birds, all the reptiles,

amphibians, I'm not putting fish here,

I'm talking about animals on the planet,

face of the planet,

and I'm not talking about insects here

because there are a lot of insects, I can

tell you that right now.

But put all that on one side, and on the

other side

put human beings and all of our animals,

by that I mean pets as well as livestock

animals,

and now weigh them. Which do you think

will weigh more?

Well maybe because I'm asking this

question you know

you might have assumed that the right

answer would be

human beings and our animals, and

that's absolutely right.

But by how much? What do you think that

number actually is?

Well I guess I should do drum roll again

here, but

here it is.

All the wild animals on the planet,

mammals, birds, reptiles, amphibians,

constitute only 3% of the

planet's biomass.

97%, so that scale would go

way down, and 97% are human beings and our animals,

and that's livestock animals and pets.

So regarding that,

you know there's seven and three quarter

billion people on the planet right now.

Pets? Part of it obviously, but not a

big part, not as many- nearly as many pets

as we have human beings. So if you look

at dogs and

cats together like a billion and a half

compared to seven and three-quarter

billion people, not nearly as much.

Where all this masses coming from are

the animals that we maintain

for food and other products. We generally

have a global herd of

70 billion, and that's billion with a “B,”

livestock animals for food and other

products.

So do the math, with seven and three

quarter billion people that translates

into roughly, at any given time,

ten livestock animals are being kept for

every person.

But we're going to talk- conclude this

lecture today talking about

environmental and climate justice,
and there's an injustice there or an
inequality there,
in that some countries like the United
States eat a ton of
meat, and in other countries like for
example
India and Bangladesh, or Indonesia
especially, they eat very little meat. So
for every American it's more than 10
livestock animals being kept, it's a lot
more because we proportionately eat a lot
more meat. And by the way,
that's in any given
year, at any given time, where they're
being kept in- Livestock animals don't
have very long
lifespans, we've you know basically bred
them over the years to
grow very quickly, to size and
they're killed.
So what that means for Americans is not
only that we have far more than you know
10 animals for us at any given time,
but over our lifetime we're talking
about you know more than

100 animals, a lot more,

will exist for us and ultimately be

killed for

us. So you can see,

again this is not an- we're talking

about extinction here, we're just talking

about the fact that

we now have you know

changed the face of the earth for

animals.

No longer wild animals dominate, but

rather you know animals that human beings

have bred. Let's continue talking about

plants and animals.

So what does a wild animal do when faced

with something like climate change and

other

human issues like you know loss of

habitat? Really

you know they have three options. One is

to adapt, and by that I mean evolve,

this is evolution. The second is to

migrate,

to move to a core place, or a place

the climate hasn't changed in the same

way. And the third, unfortunately, is to die.

So let's look at these three here.

Adapt.

So you know evolution is an amazing

process

right. In the last 30 million years for

example,

the planet has been slowly cooling in

part because of all that CO_2, all that

carbon,

all the CO_2 had been taken out of the

atmosphere and

safely had its carbon stored

underground.

During that time, it's really been

sort of I would call like the

great warm blooded revolution,

and so far as animals that were

particularly well suited to this, like

dinosaurs wouldn't have been, but

warm blooded animals like mammals and

birds

are particularly well suited to this

because you know we can

deal with colder temperatures and all.

During that time, you know 30 million

years, an enormous amount of evolution
was able to take place as the planet
slowly cooled.
You know even the last three million
years right, you know we evolved from
Lucy, a little like you know
chimp-sized animal, to become modern
human beings. So
even at three million years, a profound
amount of evolution-
change can happen because of evolution,
evolution is really remarkable
given enough time. Unfortunately,
this is happening too fast, and that was
the problem with remember that big
extinction of anthro Permian-Triassic
event
because evolution just isn't quick
enough. So recall what I said, and it
seems like a long time, that the
climate's warmed by 1.8 degrees
fahrenheit
or one degree celsius since 1880. Well
that's 140 years, and that sounds like a
long time in human
terms, it is, but it's actually not even

in human terms

because that's not that many generations

of human beings, that's you know

three or four or five generations of

human beings.

That is not a sufficient amount of time

for evolution to significantly change

our species,

nor is it for most mammals, or even birds,

even animals that have you know

that a generation is only a year.

Well that's 140 generations, can

evolution take place then?

Yeah it actually can, but not

sufficiently

to change a species to new

climatic conditions,

and that's the problem.

So if you can't evolve, and evolution

really isn't. I mean the only thing that

can evolve like quickly like that,

like viruses have very short

you know generations, and that's why

something like the aids virus has proven

so difficult to kind of eradicate

is because it's evolving so quickly,

and it can evolve and keep up with you

know treatments.

Anyhow, if you can't evolve, what do you

do? Well you migrate.

So right now half of life on earth, and

this is plants and animals,

is now migrating. Where is it migrating

from

and to? Well basically in direction from

the equator, where it's warmest, toward

the poles, either toward the north pole

or south pole where it's colder,

and it's happening pretty quickly too.

On land the migration rate is about 10

miles

per year, and that's plants and animals.

Plants can obviously

migrate too, as you know leaves- as plants

are spread

you know their seeds and all, they're

capable of

going in directions that work with

climate.

But it's actually happening much faster

in the oceans,

in the oceans it's about 40 miles per

year.

And 40 miles is a long- you know is quite

a distance by itself, but

you know imagine in 10 years, that's

moving it's migration to 400 miles,

that's really significant.

Even on land, we're talking about a

migration of a hundred miles in a decade.

So this is a big deal, and it's

happening now across the planet.

I have to give you one example

because

my daughter finds this, my five-year-old

daughter, finds this very cute.

So grizzly bears are exactly in this

model,

they are moving north because- toward the

north pole because it's getting warmer

where they had lived before.

But at the same time, polar bears are

actually moving down because

they lived on ice sheets in part and

those ice sheets are now breaking up, so

they have to go to

lower areas. And these two populations

are colliding,

and as it turns out, they can actually

produce a viable offspring.

So you take a polar bear, and polar bear

mates with a grizzly bear,

and they produce, what my daughter finds

to be exceptionally cute,

a pizzly bear. And the first pizzly bear

was discovered in the wild in 2006,

and they're actually viable, so it's

not like

a hybrid, like a mule that can't

in turn

breed, they can actually create new

pizzly bears. So in that sense, they're

like

their own little species. But this is

very unusual that something like this

would happen,

this is a result of migration, and it is

kind of evolution, but it's a short you

know circuit on evolution, which is great

for the pizzly bear, they become more

viable because of it,

but few animals are so fortunate

as cute little pizzly bears.

It can also have worrisome consequences, including for human beings, because you

know

we have a range of diseases that we kind

of thought of as generally tropical,

things like malaria, more recently Zika,

well these are now moving up. And

actually I made this slide a while back,

and there were just

200 cases of Zika in the US, which again

is like a tropical disease, you wouldn't

expect

that there are considerably more now

that have happened.

So we can expect this, a whole range of

new diseases,

moving up into the continental United

States,

and really you know across the

planet with all this life

moving all kind of stuff is going to

happen, and this is just an example of it.

Yeah, so then there's option number three.

If life can't evolve quickly enough,

which it can't,

and it can't migrate or migrate

adequately, the only option is to die.

So the example here, and it's a huge one,

is coral. So you may know like coral,

you've seen pictures of coral reefs in

the ocean and all,

and it actually looks kind of like a

rock really right.

You may not know, or maybe you did

know, it is in fact an animal.

And the problem is, because it's you know

firmly rooted there like a rock, it can't

migrate very successfully, it can move

you know

it can move a little, but not a lot.

The problem is two things are happening

to the oceans, and

I'll talk about those in detail, but I'll

just give you and tell them to you

here. One, the temperature of the ocean is

rising. So with global warming, not only

is the atmosphere rising, but turns out

the ocean is rising a lot more.

So temperatures rising, and you know if

coral were like you know other

you know ocean life, it would move that

40 miles a year, but it can't.

The other problem is happening is CO_2 in

the atmosphere has been increasing, I
mentioned it's you know increased by 135
parts per million since Shakespeare's
time.
Well it's in contact with the oceans,
over three quarters of the globe right,
and the atmosphere
is exchanging CO_2
and it's going into the oceans, and
that's making the ocean just like
sulfuric- like I mentioned sulfur
dioxide creates you know acid rain.
Well it's increasing the acidity of the
ocean, and some animals
and plants are very susceptible to that
little bit of
acid change, ph balance change, and it
turns out the coral is one of them.
So what this means with you know, it
can't migrate, and it's getting too warm
and too acidity,
and you know we call it ocean
acidification.
So here's the extraordinary number,
and that is in the past 30 years, it's
not a long time,

half of the world's coral has died by

2030- by 2050, and that's just 30 years

in the future

right. 90% of the world's coral has died.

There's a an interesting film called

‘Chasing Coral,’ it used to stream on Netflix,

I'm sure you can find it elsewhere,

that actually takes up this issue. And

this is a problem, and it's a problem for

people too

because you know coral lies on the

continental shelf

right off the ocean- right off the coast

and all. There are

you know very enmeshed ecosystems there

right because

in coral, you know you should know little

animals and plants live that are

eaten by little fish, eaten by bigger

fish and all, and

human beings do a lot of fishing

there, and get a lot of their protein

from those you know coral reef

ecosystems right off the coast.

In fact, a billion people, and that's

billion with a “B,”

people on the planet rely on coral reef
ecosystems for their protein
and food. What's going to happen within
30 years when that's gone away?
I mean how will that impact those human
beings? Well
you can see it's a problem. So
yeah, the only option is to die if you
can't do anything else. So
kind of a grim picture for plants and
animals, but I want to talk more
generally here about the oceans and
and land now. And
you know regarding what I just said,
I put a number on it, temperature has
been rising in
the atmosphere again 1.8 degree
fahrenheit, since 1880.
Well fortunately for us on the land,
and really fortunately, the oceans have
absorbed the overwhelming
amount of that heat.
90% of the heat has been absorbed
by the oceans.
And again, that's great for us here on
land.

It's also the case that CO_2, I

mentioned it's like 135

parts per million increase since

Shakespeare's time,

well that would be a lot higher too, but

again great for us here on land

in that the- because the oceans

and atmosphere are in contact, over 75%

of the planet,

CO_2 has been exchanged from the

atmosphere and gone directly into the

ocean. So

not only have the ocean sapped

incredible amount of heat out of the

atmosphere,

they've sapped a good bit of CO_2 out as

well. And yeah

really great for us here on land, not

great at all

for the animals and plants living in the

ocean, because again that huge heat

you know jump, as well as CO_2, is

proven you know

well deadly for coral and the range of

other life.

And coral's just one example, so kelp

forest

again very important because just like

you know on the continental shelf, just

like coral reefs are home to ecosystems,

whole ecosystems are based in kelp

forests, and

kelp is dying as well. And

certain animals, there are lots of

different ones, but like sea turtles are

particularly susceptible to

these temperature, and acid changes, and

ph

changes, and there are a whole lot of

other animals in all that are

susceptible to this. So something else is

happening, and this is the one you may

know or I think a lot of people

think most about,

and that is climate change, like we used

to call it, global warming

is warming a globe, and the ice that

we have stored on the planet is melting.

The two big ones to think about, and

actually to worry about, are the

antarctic ice shelf and the greenland

ice shelf.

These are massive sheets of ice that

when released into the

planet will result in temperature rise-

in sea level rise, but they're also going

to result in

what we're seeing here. So this is what a

globe will look like

by the end of this century if we

continue going to the way we're going,

and that is, you might have wondered what

happened to the north pole and all the

ice that's up here on the top of the

planet,

well it's all melting, and it's all going

away. By 2050

you should be, at least in the summer, be

able to sail a boat

right across the top of the planet,

and across the north pole. People have been

trying to do it already with like

ice-breaking ships, but

in 2050 it's probably going to happen,

and maybe before that.

But certainly you know by the end of the

century, we may be looking at something

like this.

And this is a good example of
something else that we need to take
into account. So I've been talking about
you know us releasing CO_2, and methane,
and other greenhouse gases,
we've been doing a lot of that, but at
some point the planet will continue to
warm
even with us doing nothing, more warm
than it is now.
And why is that? Well here's an example.
You know when this was all white up
here,
when solar energy came in from the sun, a
lot of it got
bounced back because of the white color,
and that's the way white works. That's
why
you know you often wear like white or
light colored clothing in the summer
because it reflects heat back, if you
wear like really dark clothes in the
summer,
you'll warm up and it'll be unpleasant.
Well that's what's happening to the earth-
What's

always happened with the earth is we

have that nice white color on top,

reflects a lot of heat

back into the atmos- back into space. But

look what happens when it's gone,

look at the darkness of the sea and

all, look how much darker it is, it's like

wearing a really you know blue or dark

blue

outfit in the middle of the summer,

you're going to heat up a lot more.

The planet will heat up more because of

that loss of

ice, irrespective of us putting more

greenhouse gases.

This is why some people talk about

something called a tipping point,

where we'll get to the point where we'll

heat up the planet enough

the natural processes will kick in, and

car heating it more,

and it'll get out of control, and there's

nothing we can do about it.

This little image here reminds me to

mention something.

Well all on the top of the planet here,

on the land mass, we have like a large
boreal forest right, we have a big forest
in
North America here in Alaska and all, but
in Northern Canada,
extends over here into Siberia, parts
of Northern Europe.
And as you may know, you know we have
their permafrost, which is
ground that is just frozen. But it's
not just ground because it contains a
lot of organic material, and in some
cases
it's like peat, which peat, otherwise
known as peat moss,
is actually plant material that's on its
way
to becoming like a fossil fuel, but
it's not nearly that old,
but it does contain a lot of carbon and
potentially what will- Well to think about
with fossil fuels,
what's so great about them is they've
safely been buried underground, so they
haven't allowed that carbon to
recombined with oxygen to make CO_2. In

the case of permafrost,

that ground, which has a ton of carbon in

it, has not been

deeply buried underground, but frozen

solid. So it's frozen and it can't

combine with atmospheric

oxygen. But what will happen as

the planet warms,

that permafrost is going to melt more

and more, and

climate is changing especially in the

arctic right now,

and when that happens, the carbon in

there is going to be principally

released as

methane. So it's not going to be burned

and coming up with like CO_2,

some of it will come out of CO_2, but a

lot of methane will happen, it will come

out of the ground there. And people

sometimes refer that, and it’s a controversial

term, as a methane bomb.

Sometimes to say it's not as bad as that,

but you know people

do note that again you know at some

point,

even if we don't release a lot of these
gases, you know the atmosphere will rise
because these gases are going
to
sort of naturally emit into the
atmosphere. So
yeah.
So the big thing that people know about
is sea level rise right. So all that ice
melts, you know north pole melts,
a big part of the greenland or
antarctic ice
sheets melt. It means that in this
century, and this is most conservatively,
that you know we're going to have sea
level rise of about a meter,
like nearly 40 inches. Some people argue
that it could be much more than that,
could be as much as
10 feet. Why the difference? Well models
differ, but the main thing is here it
depends on what we human beings do.
So in other words, if the world really
got its act together, the US got its act
together, and we passed something like a
really substantial Green New Deal, we

could significantly
you know cut down on the amount of sea
level rise. But if it's business as usual,
we can expect considerably more. Why this
matters is a third of the world cities
are on the coast,
and over 600 million people live within
40 feet of the ocean. So
you know traditionally people have built
their cities on waterways and all, even
back with the Gilgamesh right. Why was
the Uruk built where it was?
Because it was right on the Euphrates,
because it's easy to ship things, a lot
easier traditionally by
ship than by land because there weren't
good roads and all. As a consequence,
most of the cities on the planet are
being older, and still
you know shipping is huge, are right
there, by the
ocean. And 600 million people,
that's not quite one in 10 people on the
planet, but it's getting there, live
within 40 feet of the oceans.
So we saw in the movie ‘Before the

Flood,’ the Leonardo Dicaprio film,
what that's going to be like not only
for like low-lying islands in the
pacific,
which kind of people always look at as
an example because
those islands are completely going away,
but even something like
Miami, where Miami is now flooding.
So to put what the sea level rise
would be like in perspective, and to
do it in sort of an anthropocentric way.
If you look at Bangladesh
you know and this is with
just a two
foot sea level rise, so this is
considerably less than the most
conservative estimate for the planets,
and this is going to happen
in upcoming decades. As much as 40%
of Bangladesh will be lost because of it
with just two feet.
So closer to home, this is of course
Florida that we're looking at,
two feet of sea level rise will mean
that this much of Florida

becomes uninhabitable. The problem is
Florida
people like to go there because they
like the coast in the water,
75% of Florida's population
lives in the coastal communities of that
state.
So a huge number of people are going to
have to move,
to migrate, as a result of this,
and you know it's going to be big. And
again, this is just
two feet, nowhere near the conservative
estimate
of a meter, which we'll get by the
end of the century. So this will happen
right away.
I note here that there is another
film if you're
interested in this, the ‘Years of Living
Dangerously,’ with
comedian actor Jack Black where he
actually visits Florida as well to look
at the
problem. So yeah, significant changes to
the land,

and yeah. I wanted to also
finally talk about people, and not how
this will impact
people, because really in the next
lecture I'll be talking about that,
but especially the things we can do to
make changes.
But I wanted to talk about the issue of
justice and
social justice really. So let me jump
into this and this will make sense I
think.
There's something called environmental
justice, and it's kind of a misleading
term because it really should be
environmental
injustice, and what it means is
that poorer people and poorer countries
suffer more,
and will suffer more, from climate change
than wealthy individuals
and wealthy countries. And you know the
great irony is
the wealthier countries and individuals
are contributing more to climate change
by emitting more greenhouse gases. So

here's another

extraordinary statistic. If you look at

the poorest

3 billion people on the planet, that's

almost the poorest half

of the planet, the poorest three billion

people.

How much do you think that they have

contributed to the climate crisis?

Or more specifically, what percentage of

greenhouse gases do you think

that the poorest three billion people,

again billion with a “B,”

the poorest three billion people on the

planet have contributed?

Well they've contributed just 5%.

That means 95% of all greenhouse

gases,

this is what's causing the climate

crisis, were put there by

the wealthiest half of the planet. It's

actually even worse than that because if

you look at the

you know when most of this has been

happening, the developed world, and

that would be like North America and the

EU,

you know the countries of Europe and

Russia, they put like two-thirds of the

CO_2 into the-

of greenhouse gases in the atmosphere,

even though

they constitute just like one in eight

people on the planet. So there's an

enormous

inequity there, and the great irony is

that poorer countries are going to

suffer more, and

already are suffering. And because

we've

you know in the developed world

aggregated so much wealth and power

by way of our fossil fuel economy for

the you know over a century now,

we are in much better situation-

much better condition to be able to

respond to it. So I'll give you a local

example here.

Of course I'm here in Santa Barbara,

and Santa Barbara 2018 we had a very bad

fire called the Thomas fire,

and the Thomas fire was threatening to

destroy the city of Santa Barbara.
Santa Barbara is a very wealthy
community, and right to our north we're
connected-
we have another wealthy community called
Montecito, where all sorts of Hollywood
personalities and all live. So
yeah, wealthy community. So as a
consequence, when this fire broke out a
little
south of us here in Ventura, immediately
massive resources were brought in to
protect Santa Barbara, and Montecito, and
the area here.
At one point there were nearly 9000
firefighters mobilized, these were people
were flown in,
drove in, from immediately like 10
states around us,
plus you know airplanes are brought in
across country, all sorts of helicopters,
all sorts of resources,
hundreds of millions of dollars were
deployed to fight this.
And as a consequence, and I owe enormous
debt to

you know every one of the firefighters

because the house where I'm sitting here

this

would have no doubt burned down, it would

have burned down without that incredible

deployment of people

and machinery. But the point is,

how many countries on the planet could

mobilize

a response like that, that quickly, that

big, with that kind of equipment?

And the answer is very few. And what that

means is,

if I wasn't here in wealthy United

States, and in wealthy Santa Barbara,

my house would have burned down. And this

would have been an indirect result of

climate crisis because you know drought

conditions

caused that unusual- It's very unusual, it’s

very late in the season, we should have

had rains to

wet everything down, and the fire never

would have you know started or spread

anywhere.

But because of climate crisis, you know

my house was threatened,

and it would have burned,

but the inequity of the situation here

is that you know it didn't. If you live

in a place like Bangladesh,

where you know actually right now, during

you know monsoon season and all,

every year like 40% of the

country floods,

and will ultimately become

uninhabitable. How can Bangladesh

afford any kind of response like the US

can respond?

So that's the great irony right. Most of

the world-

half the world had very little to do

with this, and negligible

to do with it, and yet they will suffer

more, and

we in the developed world will be

protected.

So how much you know is that difference,

like person to person level?

Well the average American, I note here,

emits like 16.4 metric tons of CO_2 per

year,

or equivalent gases. That number is,
depending on
how you look at it, could be a little
debatable, it could go up to maybe 20
metric tons.
And also you have to remember that some
portions of the United States, like
Alaska,
it's much higher because it's like
actually 40 metric tons per person,
because it's colder there and all,
and it would be less here in California.
But compare 16 metric tons
to what the average person in
Sub-Saharan Africa. And for reasons
of this I'm talking about Sub-Saharan
Africa,
even though there are over 50
different countries there, and
they're very different countries, and
they emit differently, and people within
the countries emit differently,
but I just want to put them together for
a reason, it'll be clear in a moment.
If you put them all together, the average
emissions per person per year is 0.8

metric tons. So if you do the math,
that means that we in the United States,
every- the average citizen in the US
compared to the average person living in
Sub-Saharan Africa
is emitting 20 times more greenhouse
gases,
20 times more.
So while population is an issue, and you
know people will talk about
it you know. If you think about
this
here, you know since the average
person in Africa has greenhouse emission-
gas emissions that are 120th of the average
Americans,
the US is contributing still five times
more to the climate crisis than the
whole continent of Africa,
even though we have one quarter of the
people. So you'll often hear people say:
well it's all about population, the way
to solve this problem you know
climate crisis is you know dramatically
you know reduce the population of the
planet.

And then those people will often look

to

where population is increasing,

particular places in Africa and say:

ah there's the problem.

The problem with that is, you can see

it's

problematic right because we are

Americans

doing 20 times more problem. And even

if you look at our smaller population

compared to the bigger population of

that whole continent,

well still we're doing five times more.

So you know you just can't

look at it that way. Let me go to the

next slide and

unpack this a little more. And when you

have Americans, and this was very common

like in the 1970s with environmentalists,

you know suggesting that global

population is the problem and looking to

places like Africa

or India, you know suggesting that you

know

there in those countries

population was increasing

more than in the US, and they already had

big populations,

like 1.4 billion people in India right

now,

they said look there's the problem. But

India too,

India has you know greenhouse gas

emissions like one

tenth of the average American. So when

people

make this argument, and sometimes they

they did it

you know innocently enough I suppose, but

it's just misguided, it doesn't make

any sense. I mean how could you

point your finger at the continent of

Africa, or you know

in the Indian subcontinent, and say well

there is the problem right there,

when individuals there are emitting a

10th or even a 20th of what we are in

the United States.

It could have been simple, sometimes it

was, just

you know simple misunderstanding on

the part of people
doing that. But in today, when people
continue to do it especially,
it can be racism that we're
really looking at, right.
I mean you know looking at other people,
and blaming them for the problem. And
you know it's racist, and that's bad
enough, but what
a credible injustice it is
because the very people
making the argument are the ones
contributing the most to the problem,
that have contributed the most. The US is
the number one contributor to the
climate crisis if we look at our history.
I know that China is now, in the 20th
century, surpassed greenhouse gas
emissions
from the United States, but the US
has a longer history and put more there.
And furthermore, you know newsflash,
that China also has a population four
times bigger than the United States. So
per capita you know they can't keep up
with us, we are the number- you know we're

emitting,

there are other little- other countries

that emit a lot

per capita, but no one, no country, is

anywhere near what the United States is.

And the other issue with China, half of

Chinese

emissions, greenhouse gas emissions, are

not for

people living in China. And what I mean

by that is China's often called,

you know now in recent decades, the

workshop of the world because they

manufacture so many things.

All that manufacturing releases an

enormous amount of greenhouse gases, so

like half of the greenhouse gases that

are being released by China

are being released for people who buy

their products, other countries,

like the United States, which is you know

obviously a major trading partner, we

buy lots of their stuff. So yeah,

for the United States to cast blame

at you know the continent of Africa,

or at you know India, or at China,

yeah it's ironic, it's misguided, and

it can well be racist-

and out right racist yeah. To think of

this correctly, you need to

always think of greenhouse gas emissions

as a ratio.

And what I mean by that is, if you're

comparing Africa to the US

this way, if you're doing country to country,

you know you have to look at

population compared to

emissions. So if you know Africa has a

one

here as a whole continent, and the US

would then,

even though it has one-fourth the

population,

be at a five so. And if you did it for

you know

that relationship population

one-to-one,

and you know an African- And again, I know

that's a very bad way of looking at it,

that there are lots of different

countries

in Africa, and it's not so simple,

but I

am oversimplifying it here precisely

because

I want to draw attention to the fact

that there is an inherent racism

potential here.

But anyhow, so one average person in

Africa compared to one average American,

person in Africa is sort of one person,

you know

America is at 20. So

you know it doesn't really matter,

population

is important, and we need to address it,

and I'm not denying that, but you could

double Africa's population and the US

is still going to be twice as bad as

Africa,

more than twice as bad. So you just have

to take

population into account

with emissions at the same time. Yeah.

We refer to social inequality of

climate justice

as a social justice issue, we've

often

called this traditionally environmental
justice, and more recently, climate
justice. So
what environmental justice is,
it can refer to any sort of
environmental
problem that has a justice component. So
a
recent example would be Flint, Michigan.
So
Flint, Michigan, there's a water problem
caused by
pipes that were leaching lead into the
water system that was
you know the people were drinking, and
lead is of course you know a very
dangerous substance to be ingesting.
The problem with that was, was it was
primarily a poor, and a poor black
population, that was getting that water.
And you know it's pretty clear that the
you know the governor knew,
the mayor knew, they were aware of the
situation, they let it continue,
and they allowed you know that
population to be

poisoned in low levels. The thing is

though

you know that impacted primarily a poor

black population, and across the state,

you know

wealthy white populations comparatively

didn't get that water.

So that is an environmental justice

issue.

The more common ones are that you know

in fact,

when companies want to build factories

that are going to pollute and things,

you know where do they build them? They

build them in more

economically depressed areas. And why?

Because they make the argument that

they're going to build a factory, and

they're going to be more jobs, and the

factory's going to pay taxes to the

community, and

it's going to become a wealthier

community because of it, and

on and on and on. But the people who suffer

the most environmentally, who

are going to deal with the point source

pollution, and the chemicals there, and
the pollution in the air and all that,
are that disadvantaged group. So there's
an injustice to that, and it typically
happens that way, that the people who
suffer the most
are there at ground zero. So another
example would be coal mining industry.
Well coal mining industry goes to a very
very poor area, like Appalachia, where
it's been for
you know many many decades now of course,
and the argument is well look it brings
jobs, it brings prosperity in the
community
you know. And that you've seen with the
current presidential administration, the
same thing,
brings high-paying jobs and all. Yeah
well, but
the environmental devastation to hold
communities, and we're talking about like
mountaintop removal where
the whole mountaintops are literally cut
down, an incredible amount of pollution
and all.

That happens to those communities, so
there's a credible
injustice in all that, and we call that
environmental injustice.
Climate justice is a form of
environmental injustice-
but with environmental justice, but
in this case larger because it's not
like the example of a factory where you
know it's emitting
pollution or problems right there around
the factory,
only the people right around the factory,
or maybe downstream of a river or
something would suffer.
But here, because of the nature of it,
it impacts everybody everywhere. So what
I mean by that is,
if I you know burn a gallon of gasoline
in a car here in the United States, or
someone does it across the planet,
it all puts CO_2 in the atmosphere that
will increase the temperature
of the planet and cause other you know
weather problems, climate changes.
So it doesn't really matter where it

happens across the planet
because that is truly a global issue.
And
it is the case, going you know back to
the examples I've given,
that poorer countries just aren't going
to be able to
muster a response to this, and
they're going to suffer more,
more people will die in those countries,
more people will suffer in those
countries
than will in wealthier countries. So
that's the injustice of the climate
crisis. And again,
what an ironic one right because the
developed world has benefited most by it,
has aggregated a ton of money through
its fossil fuel economies,
and at the same time it is you know
not going to suffer as much because
of it.
Yeah so. And these are often
interrelated, so one of the reasons I had
you watch the ‘True Cost; documentary
is because there's social justice issues,

the way people have to suffer in
factories, dangerous factories and all
that.
But then there are environmental costs
too because you know
factories are not only making people
work in really bad dangerous conditions,
they're also polluting their air, and in
some cases,
like completely destroying their local
aquifers, the water sources they
have.
Yeah so,
let me pop back on the screen here.
Not a very
optimistic way to end the lecture,
and for that matter kind of a downer
of a lecture right.
Yeah. But hey look
you need to know, and you may have known
a lot of this already, it may have just
been a recap for you, you may have
gotten a couple little things, or may
have learned a lot, I don't know. But
hopefully everyone is pretty much
on the same page

with some idea of the enormity of the
problem, and what's causing it and all.
So yeah, depressing. But okay,
not to worry too much because the
lecture coming up
is not you know the climate crisis what
it is, but the climate crisis what each
of us can do about it, and the good news
is that each of us can do
a lot about it, significant things, and
we're going to talk about that. And
this is I think a fair way of concluding
the class because
you know the kind of reevaluation of
life
that Henry David Thoreau and the Buddha
did can
help us make the sort of changes that
are necessary. So
again, this course being the way it's set
up, we're not going to talk about a lot
of technology coming up in the next
lecture, not a lot about windmills and
and
solar panels, although they're both great,
looking at solar panels on my house

right now.

But on the other hand, we have to really

come to grips with the fact that we need

to make significant cultural changes,

personal changes, in response to the

climate crisis.

The good news is, if Thoreau and the

Buddha are right,

we will be happier, and live better, more

fulfilled lives in the bargain.

So in the same way that like climate

justice

is like a lose-lose for people, this is a

win-win,

not only does the planet benefit, but

human beings stand to

benefit as well, you stand to benefit,

personally we all do.

So we'll take that up next time. And

if you're a little depressed

right now, maybe you should jump right in

and watch that lecture

instead of you know sitting for a few

days just

feeling sad over the whole thing. Okay,

anyhow. Boy I wish I had made a little

happier

way of concluding, but watch that

next lecture, it's a good

deal happier.

Okay, take care.