

# Science AMA Series: We are marine scientists, Ask Us Anything about why communicating about ocean and environmental science is more important than ever!

MarineScientists<sup>1</sup> and r/Science AMAs<sup>1</sup>

<sup>1</sup>Affiliation not available

April 17, 2023

## Abstract

Hi Reddit! We are scientists at UC Davis, Bodega Marine Laboratory, and Coastal & Marine Sciences Institute interested in a range of processes in the ocean. We are currently exploring new ideas and techniques in communicating the science of the ocean to the greater public. We are interested in talking with you about how exciting ocean science is, your concerns for the ocean, pursuing a career in oceanography, and how we can better communicate the importance of the ocean to our everyday lives. Dr. Kristin Aquilino is the lead scientist for the Endangered White Abalone breeding program, operated by NOAA and UC Davis. A native Iowan, she feels equally at home among cornfields and kelp forests. Her Ph.D. is from UC Davis. Dr. Carlye Peterson is a postdoctoral scholar in the Department of Earth & Planetary Sciences, interested in how 3D visualization can assist students in understanding powerful scientific concepts in the earth and ocean. Her Ph.D. is from UC Santa Barbara. Aaron Ninokawa is currently a Ph.D. student in the Graduate Group in Ecology at Bodega Marine Laboratory. He is interested in how changing ocean chemistry may alter environments and ecosystems in the ocean. He has traveled around the world to study coral reefs and unique ocean environments. Dr. Tessa Hill is an Associate Professor in the Department of Earth & Planetary Sciences & Bodega Marine Laboratory, and an Associate Director of the Coastal & Marine Sciences Institute. She studies ocean climate change and teaches courses on science communication. We will answer questions from 3-4pm EST, and we are looking forward to speaking with you!

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MARINESCIENTISTS [R/SCIENCE](#)

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The United States has an incoming President and staff that do not believe in climate change and has talked about getting rid of the EPA. Do these types of political stances have any effect on the work that you do (ex. Funding, increased pollution)?

[snotcrust](#)

KAQ - This is a big, important question. Many of my colleagues and I certainly have serious concerns about this. First, because many of us receive federal funding for our work through agencies such as National Science Foundation, National Oceanic and Atmospheric Association, National Institute of Health. Second because I believe the President of the United State and his/her cabinet set the tone for how science is used to inform decision making. Science is an incredible tool for informing policy that improves our standard of living, and some of the greatest scientific discoveries in the country happened during times when scientific research was well-supported both politically and financially.

IIRC, oceans are becoming more acidic because they are absorbing more CO2. But to what extent? CO2 is barely acidic.

Also, could this pH change kill off plankton?

In general, could the oceans be acting as sort of a "buffer" against climate change, meaning that once

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they can't handle it any more, climate change effects suddenly increase in frequency and intensity?

[dv](#)

AN: The others have answered this as I would have. Thanks for the question and thanks to [/u/JesusAteYourBaby](#) and [/u/micromonas](#) for their joint answer.

What areas in the field of marine science are good starting places for careers? Which seem to be getting the most funding?

As a wildlife biologist with tons of experience with bats, I have found it difficult to transition into marine science despite having trained in sampling techniques in undergrad (electrofishing, otolith and stomach dissections, telemetry, experimental design)? I'd like to switch gears before pursuing graduate school if at all possible, but the jobs don't seem to be as prevalent or willing to hire newcomers.

Thanks for doing this AMA!

[AFlightOfStairs](#)

KAq - Thank you for this question! I grew up in Iowa, about as far from the ocean as you can get, and my interest in marine science didn't really begin to develop until I was applying to graduate school. While there are unique aspects of marine science compared to terrestrial science, the same principles of physics, chemistry, ecology, and evolutionary biology underlie both. I started my career as an undergraduate in agricultural and freshwater systems and was able to apply those to a marine system as a graduate student. I think it can be a huge advantage to approach a system from a unique perspective. A great way to get going is to start volunteering in labs or with groups that interest you!

I find that interdisciplinary science and science that has links to management are most attractive to funders.

Scientists seem to struggle with communicating their findings effectively, from first step findings being interpreted by the public as "cures" to global warming being interpreted as a hoax because it's too cold out.

The crux of the issue is that they are scientists, not marketers. Are there currently any organizations or businesses that specialize in translating scientific news into language that gives the public a more accurate feel for bottom line findings? Or movements towards letting scientists "outsource" their announcements to professionals who know how to get laymen excited for the right reasons? I'd also wonder whether there is anything in place to blacklist or chastise media outlets that consistently sensationalize or misrepresent science news.

[LudovicoSpecs](#)

TMH: Thanks for this question. I will refer you to several sources that I think are great for helping scientists find their core messages.

<http://www.compassonline.org/> <https://www.aaas.org/pes/communicatingscience>  
<http://www.centerforcommunicatingscience.org/>

As a city dweller, what is the best thing (or things) I can do to play my part in protecting the oceans? Are there consumer choices I can make or behaviours I can change to do my part?

[MontmorencyWHAT](#)

KAq - There are so many ways in which we can all help protect the oceans, no matter where we live! We can make sustainable choices in our daily lives by using less energy and eating sustainable

seafood. We can also use our political voices by voting responsibly and letting our local and national representatives know our concerns about ocean health. Even striking up conversations with family and friends about ocean issues helps us all stay more engaged and informed.

Climate change has, unfortunately, become as much of a political controversy as a scientific issue. It seems to me that for whatever reason, the current arguments communicating the existence of climate change just aren't convincing to much of the general populace--which is imperative for both environmental action and research funding. With your focus on communication in science, have you and those in your field considered rethinking your approach to the issue? *It seems to me that you could accomplish many of the same goals--with much less political controversy--by reframing the argument in terms of pollution.* Pollution is the essentially the same root issue, and one that is directly observable by the general populace and is directly actionable. No one thinks pollution is a hoax. While it pains me to suggest a refocus from the ultimate scientific issue that is climate change, perhaps it is time we shift our direction in communication in the name of effectiveness. What do you think?

[ModernMuse](#)

CP: Thanks for posting this excellent question! When I teach climate change and global warming, my students often ask why this is such a political issue. Climate change is a controversial and political issue because the solutions involve societal changes and economic solutions. There is so much money being made by industries that heavily rely on using fossil fuels, from plastics to industrialization to travel to land use practices, that there is a lot of inertia to change.

I agree with your point that pollution is a part of the climate change problem, but not the only issue. Many people argue that a good way to frame the climate change issue is to appeal to people's emotions. Climate scientist Dr. Katharine Hayhoe does a really good job of this, see her Elevator Pitch here <https://youtu.be/PGmk-4bplVs>

Not knowing anything about marine biology myself. I was wondering if you guys could list and perhaps rank what you think are the most important issues facing the oceans that can and need to be addressed by us?

Thank you.

[SchrodingerE](#)

CP: Thank you for posting this question! I agree with [/u/westcoastbiscuit](#) but would argue that climate change is a very important issue that will have many repercussions for the ocean. I would rank sea surface temperature and ocean acidification higher because these changes will make life more difficult for organisms low on the food chain which decreases amount/quality of food for organisms high on the food chain. I will add that rising sea level (from both melting land ice and temperature rise) will largely impact coastal communities and infrastructure, which will be more difficult for developing countries to deal with.

Is there a practical way, whether theoretical or real, to clean the Pacific garbage patch? I sure hope so as maintaining the healthiness of our seas is and will be critical to our long term survival on this rock.

Followup, less realistic and more theoretical, but how realistic/possible is it to construct an underwater city, like say, rapture from Bioshock?

[SoyMurcielago](#)

KAq - The large majority of the plastic trash in the ocean is so small that it would be exceedingly difficult to remove. A more attainable approach is probably to start to do a better job of limiting the large quantity of trash that is still making its way to the ocean. There is a lot of great research and

policy surrounding how we can reduce the input of plastic into the ocean, including our colleague Chelsea Rochman at University of Toronto (<https://rochmanlab.com/>).

I'm not sure about the logistics of building an underwater city, but if anyone figures it out, I'd love to visit.

Hi All, thank you for doing this AMA. I think my question would be best addressed by Dr. Hill but I would love to hear everyone else's response.

I'm currently involved in a national project where I communicate climate change, its impacts, and measures to adapt to its effects and mitigate emissions to people working in NGOs and Indigenous Peoples in an archipelagic country. Most are aware of what climate change is because our country has been increasingly vulnerable to extreme weather events, temperature anomalies affecting people's health, and rising sea levels in coastal communities but do not really understand how human activities have contributed to these changes. Communicating the science of climate change is a little challenging most especially to non-English speakers since some terms or concepts do not translate well to our native language and more so in different dialects in different regions. I try to explain it better by giving experiential examples they can relate with and used more figures and illustrations but sometimes still get puzzled looks (I am limited to my regional dialect and English).

Is there a better way for me to communicate this, and at the very least cut through the language barrier even a little bit? Are there resources I can refer to that can help me improve how I present a complex topic to laymen? Based on your experience, what seems to be effective?

[AudiWanKenobi](#)

TMH: Hi and thank you so much for posting this question, and for the important work that you do.

I am not sure I have an easy answer to your question, but I would recommend trying to come up with very local examples of how climate change is impacting people, their food, and their health, so that it feels very personal. I will post a couple of resources here that we have found helpful in our class:

<http://climateinterpreter.org/resource/changing-climate-conversation-metaphor-and-value-reframe-cards>

<http://www.psr.org/assets/pdfs/connecting-on-climate.pdf>

Thanks for doing this AMA. My educational background is in ocean policy and environmental economics, and science communications/policy is a major component of my career path. Can you share any stand out examples of people in the field that are creatively engaging the public in ocean science/policy?

(e.g.: I'm a huge fan of Emily Graslie at the Brain Scoop and now know way more about taxidermy and Carl Akeley than I ever imagined. :) For the uninitiated: <http://thebrainscoop.tumblr.com/>)

[northstar599](#)

TMH: Great question! in our class, we actually discussed role models in science communication and engagement, so I'll share some of our ideas here! These are the ones on the 'marine' side - there were others on our list that were in other disciplines. Jeremy Jackson (Scripps) Helen Scales (writer) Francis Chan (Oregon State University) David Hastings (Eckerd College) Neosha Kasheff (NOAA) Jane Lubchenco (OSU) Jarrett Byrnes (U Mass)

Hi all, thank you so much for doing this!

As scientists, we have to perform a balancing act between research, writing grants, outreach, teaching,

and being a functional person. I think we all agree that sci comm is important, but how does it fit into the balance? To what extent do you all think scientists are required (or not) to communicate their research to non-scientists? Do you think this changes with career stage (grad student, post doc, pre tenure, post tenure, etc)? Is sci comm more important for individuals in some disciplines (e.g. climate science) than others?

[Haliotis\\_respawned](#)

AN: Thanks for the question. I'll give my opinion here as a very early career scientist. I got into science because I have a passion to learn and share with others. My view of science is that we discover interesting things but that there's no point to it unless we spread that new knowledge. Communicating with other scientists is great for building on ideas and coming up with new projects but communicating our results with non-scientists gives our research purpose. As a grad student, most of my science communication is through schools (elementary up to undergraduate level) to inspire others to think scientifically and share why I love what I do.

As a fellow environmental scientist in the US, I want to know how can the scientific community counter the growing distrust and - for lack of a better word - devaluing of science among a large section of the population? To add to that, how can science be de-politicized, as the same aforementioned section of the population believes that science is "biased."

[ModusInRebusEst](#)

TMH: Thanks for posting this. This kind of question was answered in a few ways above, so I encourage you to read those posts too! But, some things we have found interesting & inspiring:

Americans place great trust in scientists <https://www.nsf.gov/statistics/2016/nsb20161/#/>

We can help convey the role of science in our lives by connecting to people's values and morals <http://www.psr.org/assets/pdfs/connecting-on-climate.pdf>

And, scientists can develop more confidence and competence in engaging with the public by taking time to get trained in science communication, like through COMPASS, AAAS or the Alan Alda Center.

I've heard of things like algae farms helping to reduce the amount of CO2 in our oceans, while simultaneously generating energy. How close are we to implementing this technology, and how effective could it really be in reversing the effect of climate change?

[rheticus](#)

TMH: Hi, and thanks for this great question. I will post a few resources here from a project that is working on this question in Puget Sound, WA:

<http://www.seattletimes.com/seattle-news/studies-testing-kelp-to-ease-effects-of-ocean-acidification/>

[http://www.nytimes.com/2016/07/05/science/fighting-ocean-acidification-through-kelp.html?\\_r=0](http://www.nytimes.com/2016/07/05/science/fighting-ocean-acidification-through-kelp.html?_r=0)

Hey guys, I have been loosely following the Fukushima power plant destruction and the reports of leakage of radioactive sludge. To my understanding it is still leaking to this day.

What effects does this have on our oceans? Will fish be safe to eat in the future? And lastly, is there a possibility there is a Godzilla growing in the Pacific somewhere? (mutations in fish or other marine animals)

[keyblade29](#)

CP: Thank you for this excellent question! This is an area of active research, and most scientists agree that the risk is extremely low. There are fish species that are totally safe, like Yellowfin Tuna which does not migrate or feed near Japan. Interestingly, the Bluefin Tuna does migrate near Japan because it makes long journeys across the Pacific in its lifetime. Learn more from the links below.

<https://www.fishwise.org/2013/12/17/update-on-the-fukushima-nuclear-power-plant-what-you-need-to-know-about-radiation-in-pacific-seafood/>

<https://www.ncbi.nlm.nih.gov/pubmed/22645346>

I highly doubt there is a Godzilla growing in the Pacific because most reptiles live on land...however large portions of the ocean remain unexplored. :-)

As many other question-askers have indicated, we have significant issues communicating scientific topics in the United States. I've always found visuals to be extremely helpful in discussing topics such as climate change and pollution. What are your go-to charts/maps/pictures when discussing your areas of research and should there be greater effort into making such visuals easy for the general public to consume?

[shiruken](#)

TMH: Thanks for asking! We do have some favorite and recommended visualizations for ocean & climate topics.

<http://vischange.org/> [https://www.youtube.com/watch?v=vA7tfz3k\\_9A](https://www.youtube.com/watch?v=vA7tfz3k_9A)  
<http://ensia.com/photos/environment-infographics/> <https://www.carbonbrief.org/six-tips-for-creating-a-good-climate-change-graphic>

Hello and thank you for doing this AMA!

I am a university student seeking a future in marine biology and oceanography. I spend my days wondering where I'll end up and what is the best move for me to make academically related to internships, connections, and grad school. If you could give one piece of advice to aspiring marine scientists what would it be?

[-TheLiberator-](#)

Great question - I highly recommend checking out the subreddit dedicated to this:

[https://www.reddit.com/r/marinebiology/comments/20m0an/official\\_subreddit\\_how\\_to\\_be\\_a\\_marine\\_biologist/?st=iw82mk88&sh=2758df19](https://www.reddit.com/r/marinebiology/comments/20m0an/official_subreddit_how_to_be_a_marine_biologist/?st=iw82mk88&sh=2758df19) Long story short, my one piece of advice: explore your options - there are a lot of options for working in marine science.

Hey all,

I am a biology/environment double major (formerly a marine science major) and I work with a foundation that, among other things, educates area students (and adults) about marine and other life and conservation. I think this is especially important in our land-locked area because without being exposed to and understanding the rest of the world, you can't expect for people to get passionate about it.

Do you all have any particular stories about what got you interested in your field? Any standout moments where you feel like you really inspired somebody or shared a bit of your passion with them?

Lastly, what is the best thing that lives in the water?

[H4RR1S\\_J](#)

AN: Thanks for the question. Personally, my interest in marine science started with fishing in lakes and streams. Wanting to understand and visualize what's happening underwater, this led me to set up an aquarium at home with fish which, naturally, led to a passion for understanding how ecosystems interact and chemical cycling (especially carbon and nitrogen). I think without access to the ocean itself, an aquarium is a great way to show people (kids especially) what's going on underwater and to introduce some of the more complicated topics. I might be a bit biased but I think the best things that live in the water (though not in salt water) are in my home aquarium (some cichlids in one tank and bichirs in another).

I distinctly remember seeing videos as a child of birds, dolphins, and other animals with their beaks, etc stuck in the plastic 6 pack holders. And I remember being told to cut them before disposing of them. I still religiously do this to this day. Is this still a "thing" or am I just remembering wrong?

[emtgreg19](#)

Great question. Actually, 6 pack holders have been photodegradable since 1989. <https://goo.gl/0KYk69> so they aren't the biggest current threat to marine life. Marine debris, however, can still be a major problem to many organisms <https://goo.gl/fZMSEn>. Fishing line can entangle turtles, fish, birds... A new study has shown that marine birds will consume plastics thinking that they are food, which gunks up their digestive track <https://goo.gl/doM9tq> and degraded plastics can still be consumed by fish, which may have human impacts as we consume fish <https://goo.gl/q2nynM>.

Where's the best scuba diving in California? (Also, hi Kris!)

[khturner](#)

KAq - I certainly have a soft spot in my heart for the rugged northern California coast (don't worry, it's not any bigger than my soft spot for the rolling plains of Iowa), but UC Davis Diving Safety officer Jason Herum would probably say the Channel Islands offer some of the best diving in the state. (Also, hi Keith!)

The northern coast of California lost most of its kelp forest the past few years. This is supposedly due to purple urchins population going out of control. What can be done to fix this?

[sixty1g](#)

There are a number of reasons why the kelp has died off in the north coast and, in many areas, sea urchins have overpopulated the area. California Department of Fish and Wildlife attributes this to a "perfect storm" of catastrophic events: 1) Sea Star Wasting Disease 2) Harmful Algal Bloom 3) El Nino 4) Warm Blob 5) Purple Urchin Bloom This article expands on each cause and how they worked together to result in kelp decline: (<https://cdfwmarine.wordpress.com/2016/03/30/perfect-storm-decimates-kelp/>)

California Department of Fish and Wildlife suggests: 1) Inform- share the blog post to help get the word out 2) Volunteer with CDFW 3) Report observations of kelp and urchins along the north coast

In Southern California, kelp forests off Palos Verdes have also become overtaken by sea urchins. A non-profit is undergoing active restoration in which they cull, or remove, sea urchins in the area. Here is the link to their project site: <http://www.santamonibabay.org/explore/in-the-ocean/kelp-forest-restoration/> This may be an appropriate approach for the north coast region. Here is a video showing the success of the restoration efforts: <https://www.youtube.com/watch?v=68-e5r6yI24&t=12s>

I'm currently an Environmental Science student at the University of Florida. I have a deep passion for

the ocean and it's marine life, especially when it comes to conservation and how our marine life fauna and flora are directly affected by climate change. What do you suggest I study as a career path for my bachelor's and Master's degree?

[mermaidmel16](#)

AN: Thanks for the interest. It sounds like you are in the right place studying Environmental Science. But there's only so much you can get out of classes. I would suggest searching the faculty lists in your department (or in marine science specific department) and finding a few that research topics you finding particularly interesting. Ask these faculty (or even other graduate students) if you can help out as a volunteer or intern or technician. While I was an undergraduate student, these experiences working in a lab and in the field are what inspired and prepared me for the work I'm doing now.

There's also this sub-reddit that's interesting:

[https://www.reddit.com/r/marinebiology/comments/20m0an/official\\_subreddit\\_how\\_to\\_be\\_a\\_marine\\_biologist/?st=iw82mk88&sh=2758df19](https://www.reddit.com/r/marinebiology/comments/20m0an/official_subreddit_how_to_be_a_marine_biologist/?st=iw82mk88&sh=2758df19)

The internet has made it really easy for people to find validation for pretty much any position they already maintained. What's the best way to convince people that they didn't start with a question and then gather objective evidence, *THEN* form a conclusion?

On a separate note... I need to quit reading internet comments (specifically about climate change.)

[Waksman](#)

KAq - Separating fact from fiction is a super important skill, especially in an age where "fake news" is being generated on purpose (e.g., <http://www.npr.org/sections/alltechconsidered/2016/11/23/503146770/npr-finds-the-head-of-a-covert-fake-news-operation-in-the-suburbs>). Understanding what kinds of credentials and citations to look for when consuming information helps sort which arguments are based on fact.

Dave Pruett (former NASA researcher and Emeritus Professor of Mathematics, James Madison University) addresses this and the differences between science and pseudoscience in a Huff Post article: [http://www.huffingtonpost.com/dave-pruett/science-vs-pseudoscience\\_b\\_3271974.html](http://www.huffingtonpost.com/dave-pruett/science-vs-pseudoscience_b_3271974.html)

Any ongoing projects utilizing ROVs? Video and data (sonar scans etc) could be very interesting to the public and help people visualize changes the environment is undergoing.

[ToneRanger2](#)

Yes! These underwater technologies are super helpful for conducting science, informing management, and for communicating about ocean change! We utilize ROVs to monitor the remaining endangered white abalone in the wild, most of which are too deep for us to survey via scuba diving:

<https://swfsc.noaa.gov/news.aspx?ParentMenuId=39&id=22033>

This question is for Mr. Ninokawa or Dr. Hill, with regards to the 1.5 degrees Celsius limit that was set out By the Paris climate conference, what kind of ecological changes can we expect to see at such an increase, both in the ocean and on land? (In terms of fisheries, how the ocean acts as a carbon sink etc)

thank you for doing the AMA! I'm currently studying civil engineering and hope to do work in the future that can contribute to sustainability

[not\\_maf](#)

AN: Thanks for the question and for being interested in helping promote sustainability. The first place I

look for information regarding ecological change due to climate change is the Intergovernmental Panel on Climate Change reports (<https://www.ipcc.ch/>). There's a report on called Impacts, Adaptation, and Vulnerability that outlines the projected effects fairly well.

Hello OP, this is probably the AMA I've had the most desire to ask questions in ever! I have some questions and honestly id be really happy even if you just answered one. First off I'm a junior in high school and I have a huge interest in environmental science, I love learning about the environment and climate change. Occasionally I even try to read studies but I can't understand any of the vocabulary to be honest. But my first question is: any recommendations on what I can do now as a junior in high school? I kind of messed up by not taking as many AP classes as I probably could but I am maintaining a good amount of As so is there anything I can do outside of school to prepare me to get into the field? Additionally, how difficult is it to break into the field of study? How do you deal with overall ignorance in our society and people simply not caring about this issue? I have honestly had periods where I felt depressed because no one seems to care or know about the issues going on. Also, what do you think of veganism as a way to help reduce carbon footprints? Does animal agriculture really make as much of an impact as vegans say? I've heard some sources say animal agriculture around the world accounts for 51% of carbon/greens house gas emissions. I know I presented a ton of questions, I would be extremely grateful for any answers you provide. Thanks.

[wooki\\_cooki](#)

CP: Thank you for you questions, Wooki\_cooki! I'll try to answer a few of your questions.

It's so nice to hear about your enthusiasm to learn science and passion your for the Earth! You haven't screwed up by not taking AP classes; take them when you can, and try to learn as much as you can. I had a geology class in high school my senior year, and that's when I decided to pursue science. The vocabulary of any discipline is one of the first things you have to try to learn, and it just takes practice. Read as much as you can, but look up words you don't understand and write down the definition and context. Just like you would practice for a 2nd language class, make vocabulary lists and test yourself repeatedly.

My advice to you as you prepare for college is to take as many math and science classes as you can, and do well in them...and do well in your other classes. It can be tough, some STEM classes can be really challenging, but don't give up, some concepts just need to be studied more.

In college, I majored in geology and took classes like calculus, biology, chemistry, physics, mineralogy, Earth's history/historical geology, petrology, sedimentology and stratigraphy, structural geology, hydrology, climatology, paleoclimatology, climate and human evolution, statistics, physical and chemical oceanography...then even more classes in oceanography, Earth systems modeling, and statistics in grad school.

People who study the environment and climate change can have backgrounds in any number of fields including (now I'm going to write a partial list, as people decide to study science at any stage in life and may come from any number of backgrounds...help me out [/u/MarineScientists](#)): geography, environmental science (economics and policy), biology, math (statistics, computer modeling), computer science, climatology, marine biology, ecology, chemistry, marine science, marine geology, physics, geophysics, oceanography (physical, chemical, biological, geological), english (language or literature majors), sedimentology, geomorphology, ....

You should also join STEM clubs at your school or near where you live. Science museums are really cool and have a lot of neat content online like <https://www.si.edu/> or <http://www.amnh.org/> and many others. Follow scientists and science organizations on social media.

People can be vegan for any number of dietary or environmental or moral/social justice/human health reasons...I'll write about what I know about the contribution of land use changes on climate change and why vegans abstain from animal products.

Land use changes usually refers to changes to the land surface (including removing trees and other vegetation) for the purpose of agriculture or ranching. Removing forests (clear-cutting, burning) for farms and cattle ranches changes the land surface from a dark-green densely-forested region to a lighter-colored less-vegetated landscape which changes the energy balance at Earth's surface. The color-change (albedo) reflects more heat and light at Earth's surface which alters the temperature and moisture balance from relatively low temperatures and high moisture (forest) to higher temperatures and lower moisture (farm or ranch). Additionally, large amounts of carbon are stored in forests, and removing that carbon by clear-cutting and burning that carbon releases CO<sub>2</sub> into the atmosphere which enhances the greenhouse effect, in turn enhancing warming. Also, animal agriculture reduces carbon storage (and area of land that removes carbon from the atmosphere) and produces a lot of methane (from farts!) another greenhouse gas that is better at trapping heat than CO<sub>2</sub>.

Wikipedia says [https://en.wikipedia.org/wiki/Land\\_use,\\_land-use\\_change\\_and\\_forestry](https://en.wikipedia.org/wiki/Land_use,_land-use_change_and_forestry) the IPCC estimates that land-use change (e.g. conversion of forest into agricultural land) contributes a net  $1.6 \pm 0.8$  Gt carbon per year to the atmosphere. For comparison, the major source of CO<sub>2</sub>, namely emissions from fossil fuel combustion and cement production amount to  $6.3 \pm 0.6$  Gt carbon per year. (<http://www.grida.no/climate/vital/10.htm>)

So roughly  $\frac{1}{4}$  to  $\frac{1}{3}$  of the carbon emissions from human society are due to agriculture (veggies and animals). One aspect to the vegan argument is that you reduce your personal carbon footprint by refusing to use, consume, or buy goods that are produced by changing the land in a way that contributes to climate change. This can include cattle ranching (beef), palm oil (in a lot of processed foods), and any number of other unsustainable agricultural practices. Burning forests for growing other crops also creates a lot of pollution nearby that is unhealthy for people who live there, for example in Indonesia <http://time.com/4562009/indonesia-haze-forest-fires-palm-oil-deforestation/> <https://www.theguardian.com/sustainable-business/2016/sep/14/indonesia-forest-fires-palm-oil-sumatra-climate-change-peat-companies-uneq>

Good luck in your studies!