

Movie Clip: Man: I just want to say one word to you. Just one word.

Young man: Yes, sir?

Man: Plastics.

Young man: Exactly how do you mean?

Man: There's a great future in plastics. What do you think of that?

Young man: Yes, I will.

Judith Kelley: That, of course, is a famous clip from the movie *The Graduate*, starring Dustin Hoffman. When it comes to plastics, just a few decades ago, they were considered the future. They were revolutionary. It's true, plastics are at the heart of so much of our lives today, from convenient food containers to computers, cell phones, and so many of the major advances of modern medicine are due to plastics, but there is a downside too, both for the environment and the climate. Over 7,800 metric tons of plastic has been produced since 1950. By 2015, the annual plastic production had approached the combined weight of the total human population.

My name is Judith Kelley. I'm Dean of the Sanford School of Public Policy here at Duke University. Welcome to our series of climate conversations. My guest today is Zoie Diana. She's a PhD candidate here at Duke who specializes in marine biology and environmental toxicology, with a special lens of our favorite, public policy. Welcome, Zoie.

Zoie Diana: Thank you for having me. I appreciate it.

Judith Kelley: First, can you make the connection for us between plastics and the climate? Because I think there are many of us who think of plastic and that plastic problem primarily as one of litter. We hear about the big plastic island in the ocean, et cetera, but it's more than that, right?

Zoie Diana: Absolutely. I think it's not super commonly known that plastics are derived from fossil fuels. Over 99% of plastics are from fossil fuels. You might hear mutterings about bio-based plastics, which would be different, but that's just a small, small sliver of the plastic that you see in your everyday lives. They're mainly derived from natural gas and also crude oil, so a lot of times at the production end is where I make the connection.

Judith Kelley: It's like solid, gas?

Zoie Diana: Yeah. To produce plastic is from crude oil, yeah.

Judith Kelley: Plastics are made primarily from fuels and gases, which of course, these are the substances we're concerned about contributing to climate change. Once they're in a solid state of plastic, they're not emitting anything, so is it the process of producing the plastic that we're concerned about when it comes to climate?

Zoie Diana: Well, so it's everything. Most of it, I think it's about 90% of the greenhouse gas emissions from plastic, are during the production phase, so they're from the polymerization. I can give a little overview of how to make plastic from your fossil fuels. You extract, whether that's oil or natural gas, then you have to refine it, and then it goes to a cracking plant where it's cracked into the many units, the mers. This is just really broad. This isn't highly scientific, but cracked into the little units, the mers. Then the polymerization is making that long polymer chain, and then you can create your resins, which make your everyday plastic items.

I think in that process overall, you have most of the greenhouse gas emissions, but even as you're using. If you're transporting raw materials, there's greenhouse gas emissions associated with it. Even plastic when it's waste, if it's litter or mismanaged waste or illegal dump sites, plastic emits methane when it's exposed to sunlight. Even if it's just sitting there in the environment, there are still issues. At every stage of the life cycle, plastic can emit greenhouse gas emissions, most of them at production, but along the way it does as well.

Judith Kelley: It's a climate problem just to have it sitting around in a giant pile somewhere, not just a litter problem? It's also a climate problem?

Zoie Diana: Yeah, absolutely, at mismanaged dump sites, illegal dump sites. Landfills have controls for keeping methane contained, but a lot of waste doesn't end up in those controlled landfills, unfortunately.

Judith Kelley: There are researchers around the world that are trying different interesting things to minimize plastic in the environment. I read recently about some kind of super worm that eats styrofoam and can break it down into biological material, et cetera. There's another project here at Duke that's related to bacteria, right? Can you tell us about that?

Zoie Diana: Yeah. Yeah, there's a great team at Duke. It's an interdisciplinary team. There's researchers at the Duke Cancer Institute, the medical school, the Marine Science and Conservation Division, and they're taking a bacterium that has two enzymes. They're called PETase and MHETase, and those enzymes have been shown to be able to degrade plastic into biodegradable products. They're trying to bioengineer these enzymes. I think of them as supercharging them, to make them even more powerful and really speed up that biodegradation process.

Judith Kelley: You worked on an interesting project where you were identifying plastic cleanup technologies from all around the world. Can you tell us about that?

Zoie Diana: Yeah. This was a really interesting project. It was through the Bass Connections program at Duke. We had from faculty to undergraduates, again, another interdisciplinary team, which a lot of the plastic pollution research that I'm involved in is. We were looking to see if after the fact, after plastics already made its way into our oceans or our waterways, our rivers, can you use technology to then capture that plastic and hopefully then be able to manage it and contain it in a landfill, or there's been projects using this plastic to recycle it or upcycle it into a new product. We were going through and just characterizing what types of technologies are out there.

We were finding, although this is after plastic has already become waste and it's out there in the environment, most of the technologies were for collecting the litter, rather than preventing it from making its way into waterways to begin with. That was one of the findings that I find interesting about how we're thinking about the problem. The various technologies varied. Some of the ones that I find most interesting are ones that I might be able to use in my own home. There's laundry balls. There's actually, when you're washing clothing, a lot of your athletic gear is made from polyester.

Judith Kelley: You lose some of it every time you wash. It goes into the wastewater. Is that right?

Zoie Diana: Exactly, yeah. The action of washing these clothes is producing microfibers, so just small plastic fibers.

Judith Kelley: Which are now being found in oceans.

Zoie Diana: Oh, yeah. They're being found in oceans or waterways. Some can be captured. I think some can be captured at wastewater treatment plants, but also we're seeing a lot, even at the Duke Marine Lab in some initial preliminary sampling. We have seen microfibers in the ocean there. Yeah, there's these laundry balls that either you put in with your washer, with the clothes as you're washing in your washing machine, or filters that can attach to then the water after you're done washing and the water drains away, filters that then filter that water and capture the fibers before they can then make their way further into the water stream. Those are some ones that I always think about when I think of some of the technologies that are out there.

Judith Kelley: That makes a lot of sense. These are all physical technologies for how we deal with plastics. You have been trying to think about a different way, a softer sort of policy solution, in a how can we change behavior way. I understand you have been thinking about bigger companies with big plastic footprints and how can we get them to change their behaviors. Can you talk a little bit about that?

Zoie Diana: Yeah, yeah, absolutely. Just a little backing up of why we go there is because when plastic has already made its way out into the ocean or after it's already waste, it's a lot harder to get it back. Preventing plastic from becoming pollution

or waste to begin with or producing unnecessary plastic, it just helps us to try to keep pace with how much plastic pollution we're creating.

Judith Kelley: Prevention is better than a cure.

Zoie Diana: Absolutely, yeah. We set out to ask are the world's largest companies ... and we're talking about large by their annual revenue, so the top 300 on the Fortune Global 500 ... are they making commitments to reduce plastic pollution in their publicly available reports, so their sustainability reports, their annual reports, and if they are making commitments, what do these commitments look like? What actions are they committing to take, and what sorts of plastic types are they targeting? We did find that 72% of the world's largest companies made at least one commitment to reduce plastic pollution, but these commitments really range.

It could be as little as one line of text or many, many pages that we were reading. In those commitments, what we were seeing was a lot of targeting just general plastic, so it was hard. They weren't exactly disclosing what the specific plastic type that they were targeting in those cases was, or packaging was also frequently targeted. Then the actions that we often saw was a heavy emphasis on recycling, so either advancing recycling or increasing the recyclable or recycled content of the plastic that they're producing.

Judith Kelley: That's good, or disappointing?

Zoie Diana: Somewhere in the middle is how I view it, but I can give a little more context of why. I think recycling is really valuable. It's really important, but it has only been shown to work up to a point. Globally, only between about 9 and 10% of plastic has been actually recycled over the last 50 years. A small percentage of plastic is actually being recycled. Seeing commitments that rely on recycling, I hope ... this can go either way. This could be maybe then in 50 years when we redo this study, there'll be greater recycling rates and I can be more optimistic when I see companies committing to recycling. It could also be, on the other hand, pushing that burden of dealing with this plastic waste to consumers, who often are the ones actually putting plastic in the recycling bin, for example.

Judith Kelley: I see. That's companies, but what about governments and government policies? Are there things you've found in your survey of the policies that are out there that some governments are undertaking that are promising?

Zoie Diana: I worked with researchers at the Nicholas Institute for Environmental Policy Solutions at Duke, and we did a survey of how governments over the last about 20 years are responding to plastic pollution. I'm really happy. We have seen there's an increased number of policies adopted annually that specifically aim to reduce plastic pollution, so that makes me hopeful.

Judith Kelley: What do you think the solution is? Because plastic is obviously a big part of our economy and how we function, and so for practical purposes, currently it's here. What do you think? If you could wave a magic wand and have us make a big change, what would that look like in respect to plastics?

Zoie Diana: I have to differentiate between all the plastic out there. There's medical plastics, which as we've seen, it's become abundantly clear during the pandemic that medical plastics, we don't have a replacement for those. They're really necessary to keep people safe. Those I'm not talking about, because we need those. We need to manage those properly. We need that sort of plastic around.

On the other end, there's plastic that I don't think we need. There's unnecessary plastics and also folks talk about problematic plastics, which I'll get to in a second. For unnecessary plastics, those are ones where maybe you order something online and it comes in a plastic bag, but then surprisingly, it's wrapped in another plastic bag below that plastic bag, and you're just wondering like, "Why is there so much plastic here?"

Judith Kelley: This happened to me yesterday. It comes in a very big box, which in order for the item not to rattle around, they have these inflatable plastic bubbles, and then also the packaging. You're like, "That's a lot of plastic."

Zoie Diana: Yes, yes. Those unnecessary plastics are ones that I really would love to see us start to phase out. That to me seems like a good place to begin. Then we get to those plastics that are in the middle, and I think of food packaging a lot for this one, where we have safe drinking water here in Durham, so we're not relying on water bottles for safe drinking water. A lot of our food might not necessarily need to be in plastic, but it is right now.

There's starting to be reuse and refill options where you can bring a jar or a reusable container of some sort to a store, refill and take that away, but that's not for all of the foods that one typically buys. That's where I think we need some more investment in reusable and alternative delivery systems, and where we can do a lot of work in that middle ground of finding other ways to deliver goods, basically.

Judith Kelley: Plastics, we won't be without them for a while, but maybe there are ways that we can continue to figure out how to substitute with other materials, or if not, at least there are people coming up with different ways of getting rid of them. What do you think the future of plastics is?

Zoie Diana: There's some recent modeling that was done that was, even if we used all of the levers that we have, all of the policy levers, all of the new technologies that are out there, amped up our recycling, even if we did all of that and had all the political will in the world, there'd still be 710 million metric tons of plastic entering the ocean between 2016 and 2040. We need more innovation. We need to really dramatically amp up our efforts, but it's exciting. There is a lot of

momentum towards reducing plastic pollution, whether it's coming from governments, whether it's international treaty. I think anecdotally, more and more people are talking about it and consumers want to see less plastic, so hopefully we'll get there.

Judith Kelley: I want to be hopeful with you. Meanwhile, if I'm listening to this and I'm thinking that I, for one, don't want to be part of the plastic problem anymore, what are some things that I can do as a consumer to contribute less to the plastic problem?

Zoie Diana: Something you can do is, when you think of where you're buying your items from, supporting those businesses that you don't see unnecessary plastic packaging. Whether they're zero-waste industry leaders or they're making marginal steps to reduce their plastic packaging, supporting those businesses is always helpful. To put on my advocacy cap, supporting if there's local policies going on in your area, such as we've seen a ton of single-use plastic bag fees, taxes and so on, popping up, as well as bans. Supporting those in your local area is always really important as well.

Judith Kelley: Maybe sometimes just keep on using some stuff you have, before you throw it out and get new stuff.

Zoie Diana: Yeah, yeah. Great point. Fixing broken things, sometimes if you can. There's been popping up shops around. I saw one here in Durham, of you can bring something in and they'll help you to fix it, instead of just throwing it out and replacing it. That's always an option too.

Judith Kelley: That's the spirit. Zoie, thank you so much for joining me today.

Zoie Diana: Thanks for having me.

Judith Kelley: Zoie Diana is a PhD candidate here at Duke University. We'll have a link to her website at ours, policy360.org. If you liked this conversation, I also invite you to listen to the first two episodes of the series. Episode 140 is about satellites, machine learning and climate change, and Episode 141 is about climate change migration. This climate series is all part of something called the Duke Climate Commitment. That's it for now. I'll be back soon with another conversation. I'm Judith Kelley.