INTEGRAL Season Four: Environmental Justice and the Common Good
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Ed Maurer, Professor, School of Engineering, Civil Engineering Department
Climate Change, Water, and the Common Good
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THERESA LADRIGAN-WHELPLEY: Welcome to INTEGRAL, a podcast production of the Ignatian Center for Jesuit Education at Santa Clara University; exploring the question: is there a common good in our common home?

I'm Theresa Ladrigan-Whelpley, the director of the Bannan Institutes in the Ignatian Center, and your host for this podcast. We're coming to you from Vari Hall on the campus of Santa Clara in the heart of Silicon Valley, California. This season of INTEGRAL, we're examining the ways in which the work of environmental justice is central to our pursuit of the common good. Today, we'll look at the impact of global climate change and explore partnerships for local adaptation.

ED MAURER: The study of how a warming planet responds and affects things at a human scale is fascinatingly complex. Research consistently shows that more impoverished countries will suffer the worst impacts and be least able to adapt to a changed climate, and future generations will bear the brunt of the suffering due to the lagged response of the earth's temperature to a changed atmosphere.

THERESA LADRIGAN-WHELPLEY: To unpack these issues, we're joined today by Ed Maurer, Professor in the School of Engineering at Santa Clara, and Bannan Institute Scholar in the Ignatian Center. Professor Maurer joined Santa Clara's Civil Engineering Department in 2003, where he teaches courses in hydraulics, hydrology, water resources, and sustainability. His professional experience includes work in municipal water supply and wastewater engineering, climate change impacts, western tribal water rights, and rural community water supply projects in Latin America. His recent research contributions involve modeling large scale hydraulic dynamics, improving long lead forecasting, and studying regional impacts of climate change, especially on water. Welcome, Ed!

ED MAURER: Thanks Theresa. Bringing the projections of climate change to a meaningful, local level has been the goal of my research for many years. The problem has become more complicated as my focus gets closer to the people on the ground, those enduring the violence of a perturbed climate and struggling to decide how to respond. Before I go deeper into this journey, any talk of global warming demands a little context and background.

Climate change is happening, it is going to continue, and humans are to blame. That’s a simplified summary of some key talking points from the latest scientific climate research reports. The blunt tone of that is not what most expect from a scientific assessment, but as scientists have been discovering more about the severity of impacts due to burning coal and oil to power cars, heat homes, grow and cook food and so on, the approaches to communicating science have also evolved.

A historical perspective can also be helpful. In the early and mid 19^{th} century, scientists whose names we know well, like Fourier and Tyndall in particular, and some you probably don’t know, like Eunice Foote, established the scientific foundation for our understanding of global warming. This is concisely summarized by a friend and colleague, Dr. Katharine Hayhoe, an atmospheric scientist at Texas Tech, in her video series “Global Weirding.”

KATHARINE HAYHOE [AUDIO CLIP]: A fascinating international cast of characters has been studying our planet's climate for almost 200 years. It started back in the 1820s with the smart French mathematician called Joseph Fourier. He figured out that, according to basic physics, our planet should be a lot colder than it is now, about 60 degrees Fahrenheit, or more than 30 degrees Celsius, colder, so why isn't it? Some 30 years later, a smart American woman gave him the answer. In the 1850s, Eunice Foote ran experiments to show that our planet has a natural blanket built into the atmosphere.

Human activities can affect the thickness of this blanket specifically by digging coal and oil and natural gas out of the ground and burning it we are pumping massive extra amounts of carbon into the atmosphere carbon that would otherwise stay buried in the ground for millions of years and what does a thicker blanket do well of course it traps more heat how much more in the 1890s a mustachioed swedish scientist named svante arrhenius calculated how much the earth would warm if we doubled or tripled the thickness of the extra carbon blanket in the atmosphere his numbers were amazingly similar to what we get from our biggest most modern supercomputers today.

ED MAURER: So while the potential for coal burning to raise the Earth's temperature has been known for well over a century, back then the effects were expected to happen in the distant future, many centuries away.

The science advanced in fits and starts through the mid 20th century. When accuracy of measurements of CO_2 levels improved it became apparent how quickly the levels were rising. The increasing levels of greenhouse gases reflected the rapidly rising population and accelerating industrialization, which meant the impacts would be much sooner, with measurable warming even just decades away. That generated a revived effort to understand how the earth might respond to increased global warming pollution. A lot of that rested on projections of how quickly we burned oil and coal. That these human-induced changes could affect the climate in potentially catastrophic ways was recognized by the 1970s, even in reports by scientists in oil companies like Exxon.

My introduction to impacts of global warming came in 1989, soon after an EPA report was released on the potential effects of climate change on the United States. My task was to map the impacts of rising sea level on San Francisco Bay and estimate the costs to low-lying infrastructure like roads, railways, and sewage treatment plants. This is one of the most robust impacts – as ocean water warms, it expands and ice sitting on land melts and flows to the sea, with the two effects combining to cause sea levels to rise. The final number we arrived at was that it would cost about one billion dollars to build levees to protect the Bay Area, or to raise things that couldn't be protected. While that's a big number, amidst all the other concerns of the day, it felt less than urgent. It wasn't until over a decade later that I returned to studying impacts of climate change on water, infrastructure, and other things important to humans.

The study of how a warming planet responds and affects things at a human scale is fascinatingly complex. It is usually approached beginning with sophisticated computer models of the earth system, tracking how water and air move through the atmosphere, land and oceans. These models conceptually cut the atmosphere and ocean into hundreds of thousands or millions of little boxes that interact with each other, solving equations describing how mass and energy move between these boxes every few minutes. Running one of these models to simulate decades or centuries in the past and into the future requires a supercomputer, so there are only a few dozen of these models in regular use around the world. They are capable of reproducing historical climate quite well. The projections into the future are done for a few different pathways that reflect how human societies and economies might develop. These trajectories of development range from the higher "we'll keep burning things as we have" to a lower "we quickly deploy sustainable technologies to remove a lot of oil and coal from our economies." There is even an extremely low pathway that has humans not just reducing emissions but finding ways to remove it so that levels actually drop. So far this century, we are at or above the highest of these pathways, which is disconcerting, but there is a lot of this story that is yet to be told. Climate models are truly incredible achievements of science, but while they capture climate dynamics and changes at large scales, they don't provide the detail needed to figure out what might happen at the scale important to people (or other living things). For instance, most of the Bay Area might be simulated as a single point on a map. This invites another avenue of science called 'downscaling' that takes the larger dynamics of climate models and translates them to a local scale that might be more useful for people trying to understand what the future might look like where they live and decide how to respond to these challenges.

Fortunately, many downscaling methods require computer resources that most of us have on our desks. The output from global climate models have been freely available for over 10 years, organized by a massive effort of climate scientists to provide the data in a uniform format via a common web interface, so anyone can access it. This is a rabbit hole I've burrowed into deeply, exploring different methods for quantifying the impacts of a warming earth on water resources, like changes in water supply and drought, enhanced snow melt, or how reservoir operation might have to change in a new climate. Downscaled data I helped to produce have also been used for looking at things like summer heat waves in urban areas and increasing wildfire severity. The changes we can expect have large bands of uncertainty, but the range is often from significant to catastrophic, not something that can be comfortably ignored.

Early in my work on downscaling and climate impacts, I was invited to share some of my findings at a seminar at San Francisco State University. I enthusiastically summarized some of my recent research, replete with dire projections of increasing heat, loss of critical snowpack, more intense rain, and the resulting increasing probability of damaging floods. When I reached the end of my talk I was asked by one student what we could do to prevent this from happening. Aside from some small personal efforts, like changing lights to CFLs (LED lights weren't common yet), turning down the heat in winter, eating less red meat, I had little concrete to offer, and nothing particularly hopeful. What a missed opportunity! It brought home the importance of providing solutions to the problems with global climate disruption, and the essential skill of communicating clearly in a way that inspires action. Though I had only a vague idea of what this might look like.

My situation was not unique. The climate science community faced numerous communication challenges, not just the difficulty in inspiring action proportional to the threat posed by a disrupted climate, but the seemingly endless task of rebutting misinformation produced by an active and well-funded anti-science campaign. If there is a silver lining in this, it is that it forced a broader interdisciplinary approach to communicating the findings of climate science and the many disciplines that study impacts to different sectors. As a water resources engineer who had been content quantifying changes in the patterns of rivers flowing into reservoirs, that meant paying more attention to the people working for agencies that operate the reservoirs to supply water to farms and cities, or engaging with the people receiving water deliveries at the end of the line.

This new challenge also inspired a sort of moral and scientific reckoning, attempting to answer some very fundamental questions, such as "should we do anything about climate change?" This is where science and the Catholic church came together in the May 2015 encyclical *Laudato Si*. Pope Francis unambiguously labeled the climate a common good, and asserted that humanity must recognize the need for change in our patterns of production and consumption to combat climate destabilization. This encyclical, and its core concept of conversion to an integral ecology, were not presented as a radical departure from church teaching, but as part of a long trajectory of Catholic social thought that Cardinal Peter Turkson outlined in a talk at Santa Clara University in November 2015.

CARDINAL PETER TURKSON [AUDIO CLIP]: And so Catholic Social Teaching since the Second Vatican Council has increasingly recognized that the care of creation is intimately connected to other Christian commitments. In particular, environmental harm compromises the commitment to promote the common good and to protect human life itself and the dignity of individuals. Human-forced climate change is unequivocally a moral issue. Therefore the Church has called for public policies to mitigate the greenhouse gas emissions and assist those most affected by the adverse effects of climate change.

ED MAURER: This document framed a moral argument for action, which can take the form of mitigation, where reliance on coal and oil are dramatically reduced to lessen future impacts, and adaptation, where we build communities that are resilient when faced with the impacts we cannot avoid. The case is not just moral: economic studies over the past 10 years consistently find that the costs of taking action today are a bargain compared to the costly damages we'll incur if we do nothing.

Research consistently shows that more impoverished countries will suffer the worst impacts and be least able to adapt to a changed climate, and future generations will bear the brunt of the suffering due to the lagged response of the earth's temperature to a changed atmosphere. Again, reframing the science in moral terms, the encyclical applies the terms intragenerational and intergenerational morality to describe the injustice embedded in these discontinuities between those responsible for causing the problem and those suffering its effects.

In fact, making a moral case for climate-friendly action has been found in some recent sociological and psychological studies to be more successful in motivating the changes in behavior needed to help prevent the more severe impacts of warming. People would rather see themselves as 'green' than 'greedy.' While personal changes will have a positive effect on ameliorating the climate change problem, Pope Francis does not shy away from the depth of change that is ultimately needed: replace consumption with sacrifice, greed with generosity, wastefulness with a spirit of sharing. Ultimately we need a liberation from fear, greed, and compulsion; we need an interdependent world with a common plan.

Pope Francis doesn't stop there. With the climate firmly identified as a common good, he makes the argument that solutions cannot be achieved without a distributional justice, a solidarity with and preferential option for the poorest of our brothers and sisters.

As an academic who has written so many papers that conclude with a hand-waving statement like "these findings will help inform responses of water managers and users of water resources," the challenge is to engage more deeply in this piece.

First, the breadth of expertise needed to understand how to engage with people who might be affected by my research demands a broad, interdisciplinary approach. Second, the research itself should be shaped by those I intend to serve. Third, if I'm serious about my research embodying a preferential option for the poor, the question of distribution of resources, whether in performing the research or in responding to the findings, must be part of the conversation. This is a tall order for an engineer accustomed to crafting narrow research questions that can mostly be answered by writing code to process data.

I am fortunate to be part of relatively new project that comes closer to reflecting this model of research. Spearheaded by Chris Bacon, a group of us representing three of the six schools and colleges at Santa Clara are working with community groups in northern Nicaragua to study food and water security – how vulnerability and risk have been experienced in the past, what adaptations have worked historically, and what might be promising pathways forward. Since global warming exacerbates current risks and vulnerabilities, looking at the impacts of and responses to the 2014-2017 regional drought and the simultaneous outbreak of coffee leaf rust can offer some key insights into potentially successful strategies for the future. Since both the drought and leaf rust are worsened by warming temperatures, the results may help craft strategies to adapt to imminent changes – the projections are for dramatic reductions in the area suitable for coffee cultivation within just a few decades.

My first instinct was to collect digital data on rainfall and projections for how that might change over this century, write code and generate graphs showing impacts that must be important to people because others had asserted this in the literature. Of particular interest is a phenomenon known as the *canícula*, a dry period from mid-July to mid-August, that happens in the middle of the rainy season. The *canícula* is important as it sets the rhythm for planting and harvesting, so changes in its duration or intensity can have profound impacts on food production. I took my findings, showing for example projections for late 21st century of a longer canícula, on a trip to Nicaragua in 2017. I unwittingly tried to lead a focus group to get some of the feedback I knew I needed. What I found was that people there viewed the problem differently than I did, and my graphs were inadequate for conveying anything meaningful to these stakeholders. Fortunately, I was bailed out and the conversation was redirected into a more productive, though no less surprising direction, revealing cultural and astronomical aspects to the *canícula* that I never would have guessed. What I learned from these conversations in rural northern Nicaragua has completely reshaped my research approach, where the new challenge is to find a way to characterize projected changes in ways that are more meaningful to farmers in the region.

While still contemplating how to redirect research in light of the information gathered on the visit, this seems a more transparent and honest approach to conducting research, where I try to be more accountable to the stakeholders I claim will benefit from my work. Dipping into the well of Laudato Si again: "True wisdom, as the fruit of self examination, dialog and generous encounter between persons, is not acquired by a mere accumulation of data." But fortunately, because it is closer to being in my wheelhouse, accumulation of data will still play a role.

THERESA LADRIGAN-WHELPLEY: Thanks for listening to INTEGRAL, a Bannan Institute podcast of the Ignatian Center for Jesuit Education at Santa Clara University. Special thanks to Ed Maurer for his contribution to today's episode.

Technical direction for INTEGRAL was provided by Fern Silva. Our Production Manager is Kaylie Erickson. Our Production Assistant is Manuel Sanchez. Thanks to Mike Whalen for advisory and editorial support. You can find us on the web at scu.edu/integral, or subscribe via iTunes, SoundCloud, Stitcher, or Podbean.

CITATIONS

- Katharine Hayhoe, Just how long have we known about climate change anyways?, Available at: https://www.youtube.com/watch?v=XpqBto89i38
- Cardinal Peter Turkson, Cardinal Peter Turkson Address at Santa Clara University, Available at: https://www.youtube.com/watch?v=CiN9Vw2R7dU