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Connect the Dots:
On Mapping Diseases, Forests, and Life at Stanford

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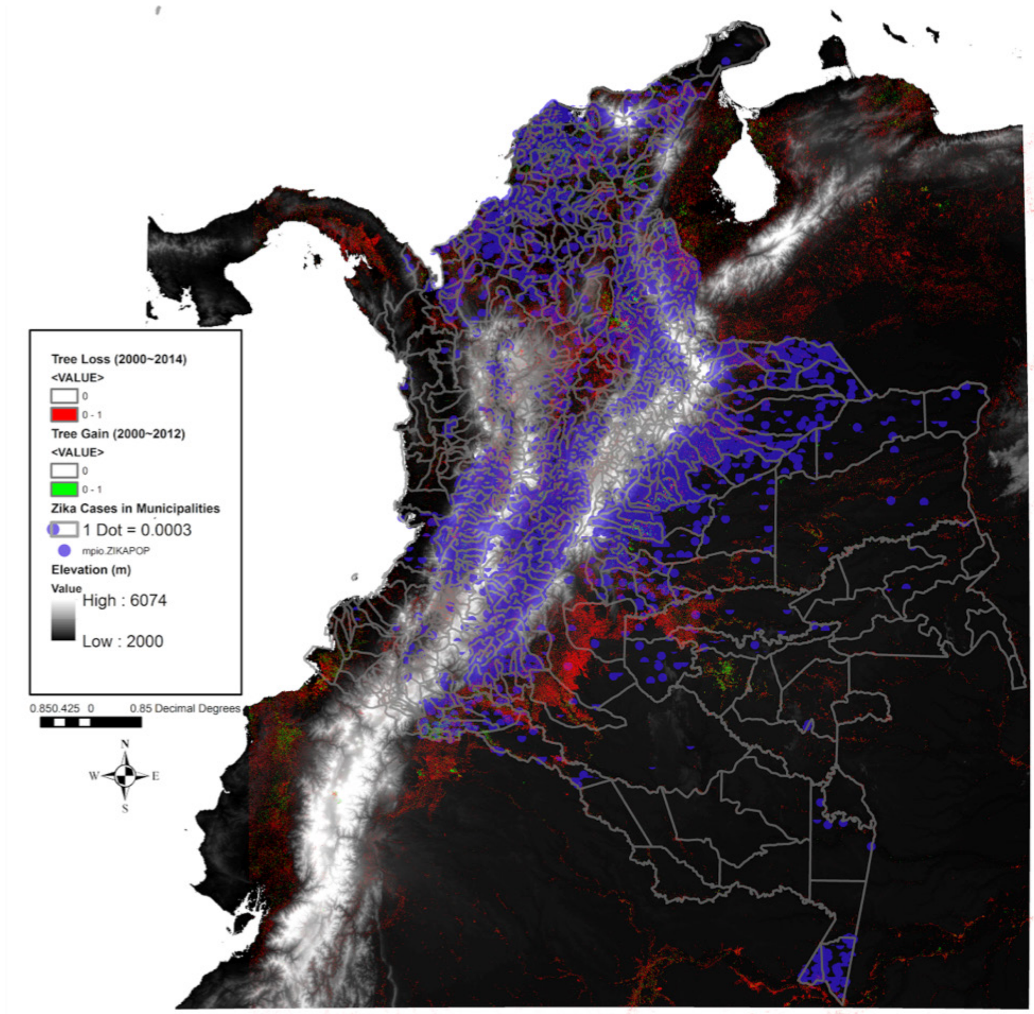


Map of Colombia with minimum elevation, Zika transmission rate, area percentage of tree loss, and area percentage of tree gain per municipality. Forest change pixel = 30 m2 , elevation pixel = 90 m2 . (developed by author, unpublished data)

I sit in a lab on the fourth floor of Herrin biology building, my fingers spouting codes. I press Enter and, within seconds, the map of global forest loss appears on my screen. The map looks like a night sky being observed from a lightless countryside. Red specks pepper the world, clusters delineating areas of especially intense deforestation. I press enter again and another map appears, but this time, it's of Zika. Blue spots, signifying the infection rate, envelop the mountain ranges of Colombia in northern South America. These blue streaks often overlap with the clusters of red that mark mass deforestation. As my eyes slowly scan the layers of digital images, my practiced mind races for clues of connections.

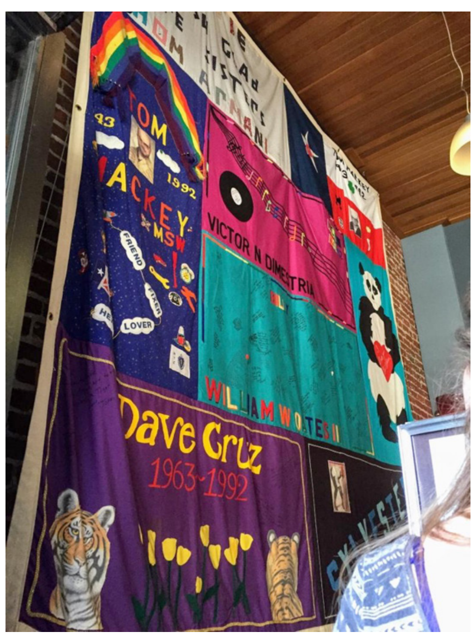
In the summer of 2015, Ixtlan de Juarez stretched out before my eyes; the lush carpet of oak trees rolled like tidal waves and I, still drunk with the aroma of deciduous flora, began rolling a transect tape methodically down the slope. I was in Oaxaca two years ago as part of a summer seminar led by professor Rodolfo Dirzo in the biology department. Nine other students and I were doing an ecological analysis of forest management. We set transects, counted oak saplings, and calculated the rejuvenation rates of the oak forest that are being managed, hopefully in a sustainable manner, by the local logging companies. After I measured the diameter of the last sapling, I straightened my aching back and took one last look at the rich hills before me. Every extent of my view was a forest, except for occasional clearing of barren

photo of Ixtlan de Juarez

land: litmus strips of anthropogenic deforestation.

Nearing the end of my freshman year, I had no idea what I wanted to do during the upcoming summer. So I applied for random jobs and programs, in desperate hopes that any of them would accept me and my summer would not be wasted. Two programs accepted me. One took place in the tropical dry forests of Oaxaca, Mexico. The other was in downtown San Francisco. Never had I imagined before then that I would be forging an interest in the intersection of those two experiences.

About a month after the seminar in Oaxaca, I returned to Stanford for a Sophomore College called "AIDS Epidemic in San Francisco." Instead of rolling tides of green oak forests, urban hill tops of rainbow-tattered crosswalks and narrow streets filled with angry cars and exuberant tourists produced a melancholic cacophony of human urgency. One night, we interviewed one the drag queens at a drag club. She tearfully recounted the memories of a dear friend who lost her battle to AIDS. The day after the interview, when we visited the National AIDS Memorial Grove, we found the friend's name engraved on the sidewalk along with countless others'. We bowed our heads in silence and I, who gave up counting the names, stared at another blatant display of loss.



Quilts knitted in memory of AIDS victims

It is difficult to trace diseases such as HIV back to their origins. It is commonly understood that HIV originated from apes and slowly spread across Africa. The first infected humans probably hunted infected chimpanzees for meat and came into contact with the virus-ridden blood. The first official case of infection dates back to 1959, just twenty years before the start of an epidemic that has now killed 35 million people.

Could these lives have been saved? What could we have done differently? As I continued to ponder these questions, I found myself drawing upon two of my vastly different experiences.

Forests of all types cover approximately 31 percent of the world's land surface and provide important ecosystem services to us humans, including nutrient cycling, genetic resources, and even spiritual experiences. (World Bank, 2016) Unfortunately, we are rapidly cutting these forests down for agriculture, logging, and urban development. In 2016, the Brazilian government released an annual study that showed that the deforestation rate has increased by 29 percent since last year. (Butler, 2016)

Many scientists argue that destroying these forests are resulting in increased incidence of viruses (Norris, 2014). Barbara Han, a disease ecologist at the Cary Institute of Ecosystem Studies, uses an analogy of penetrating a balloon filled with viruses. "Whatever survives, spills out. Deforestation is closely tied to disease emergence." (Doucleff, 2017)

In February of 2016, several months after the eventful summer, the World Health Organization declared an outbreak of Zika virus a Public Health Emergency of International Concern. Within months, the virus infected people all over Latin America. (Nebehay & Hirschler, 2016) To experienced epidemiologists, Zika is just another emerging infectious disease. To me, it begged more questions. Why Latin America? How plausible would it be for the virus emergence to be related to the deforestation of the Amazon forests?

I brought my questions to professor Erin Mordecai, who studies vector-borne diseases and the effects of climate change. We ended up arranging a project for me to do the summer after my sophomore year. During those ten weeks, I made maps of the Zika epidemic and forest loss, performed spatial analysis on both, and discovered interesting interactions and possible connections between them. I learned that, although deforestation plays an important part in the patterns of Zika, its effects can be amplified when coupled with the variables of urbanization. In a way, urbanization is deforestation's partner-in-crime.

Although at times I struggled with the technicalities of this project, I thoroughly enjoyed conducting research. The highlight of that summer was the poster session. A woman came up to me and told me she was from Colombia. She said her mother has dengue, another emerging infectious disease rampant in South America. As a native to Colombia and a daughter of someone with an infectious disease, she told me how concerned she was with the increasing numbers of people infected with diseases across the globe. "Your map captivates me," she said. "It tells many stories like mine."

As of November of 2016, Zika is no longer considered a global emergency. (McNeil, 2016) However, my work continues. As an Earth Systems major interested in spatial epidemiology, I am now preparing to write an honors thesis to continue studying how deforestation affects vector-borne diseases like Zika. Several people, intrigued by the interdisciplinary nature of my research project, have asked me, "How did you come up with this project?" To be frank, I do not believe I came up with it. Rather, the project, came to me when I decided to take chances on seeing the world from multiple perspectives.

Back in my lab, I continue fine-tuning the multi-layered map on my laptop. With a single stroke on the trackpad, my cursor can fly over Colombia, Oaxaca, and San Francisco, zooming into every street and peering into every coordinate. But I will never forget hugging the drag queen in San Francisco, tenderly caressing the young leaves of oak trees in Oaxaca, and seeking, with whatever I can offer, to protect the vulnerable.

References

Butler, Rhett A. "Brazil: deforestation in the Amazon increased 29% over last year." Conservation news. 01 Dec. 2016. Web. 10 Mar. 2017.

Doucleff, Michaeleen and Jane Greenhalgh. "Why Killer Viruses Are On The Rise". NPR.org. N.p., 2017. Web. 10 Mar. 2017.

McNeil, Donald. "Zika Is No Longer A Global Emergency, W.H.O. Says". Nytimes.com. N.p., 2016. Web. 10 Mar. 2017.

Nebehay, Stephanie and Ben Hirschler. "WHO Declares Zika A Global Health Emergency". Scientific American. N.p., 2016. Web. 10 Mar. 2017.

Norris, Douglas E. "Mosquito-Borne Diseases As A Consequence Of Land Use Change". EcoHealth 1.1 (2004): 19-24. Web. 10 Mar. 2017.

World Bank. Forest area (% of land area). Web. 10 Mar. 2017.