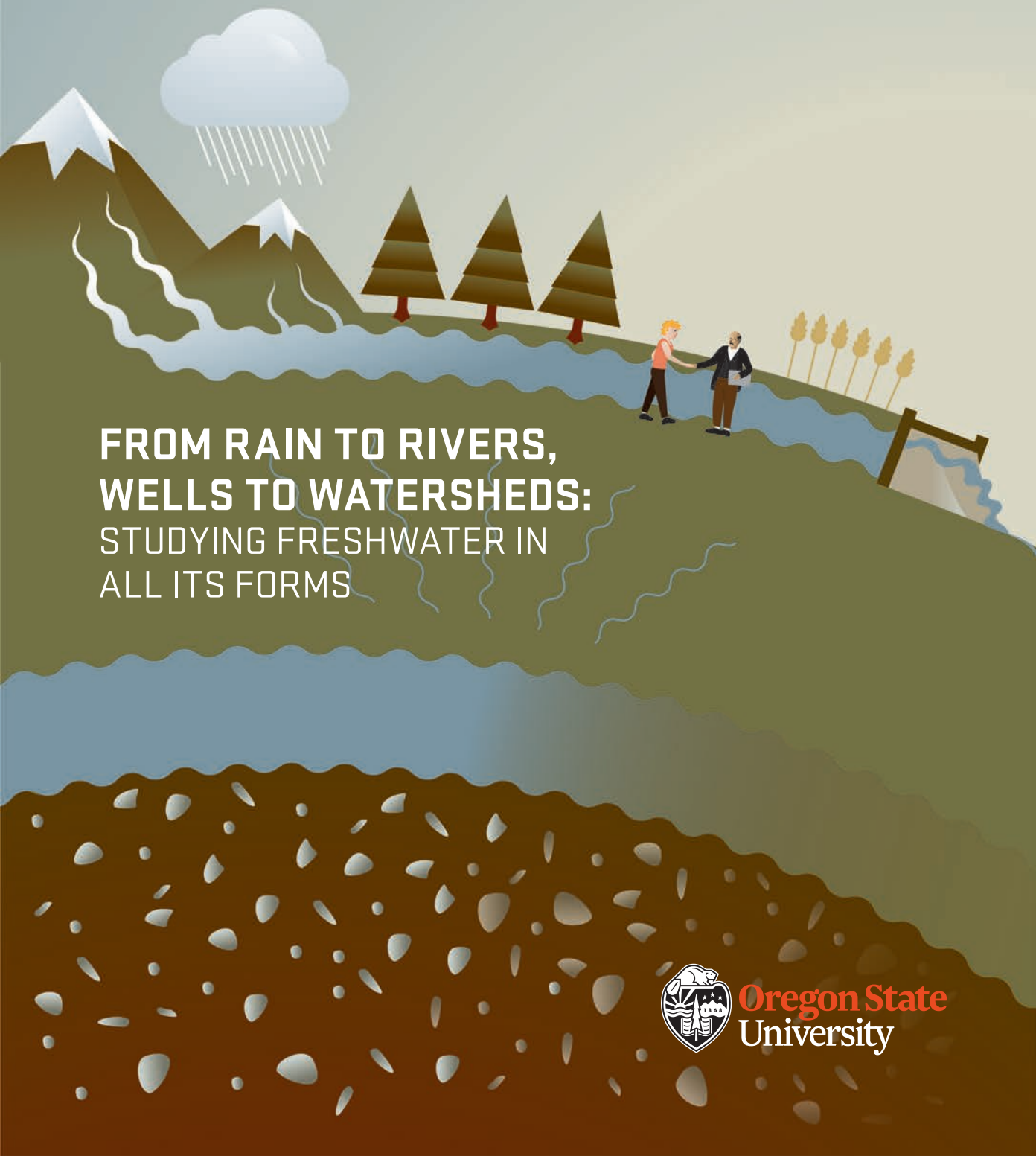
COLLEGE OF EARTH, OCEAN, AND ATMOSPHERIC SCIENCES | 2020

ELEMENTS



FROM RAIN TO RIVERS, WELLS TO WATERSHEDS:
STUDYING FRESHWATER IN ALL ITS FORMS

Oregon State University

A confluence of expertise

In 2015, Oregon was facing one of its worst droughts on record. A warm winter and low snowpack made a dangerous dent in our water reserves for the summer, impacting agriculture, fish, recreation and more. That same year, the United Nations adopted 17 sustainable development goals. Clean water and sanitation were among the priorities for global peace and prosperity. While miles apart in distance and scope, the two events were connected: Both were a clarion call on behalf of this vital yet finite resource.

Whether contaminated drinking water in Flint, Michigan, or the slow disappearance of the Aral Sea in Central Asia, the fragility of freshwater surrounds us — a stark reminder of how much the entire planet depends on this resource.

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About Elements
Elements is a magazine for alumni and friends of the College of Earth, Ocean, and Atmospheric Sciences focused on the college's cutting-edge research and programs.

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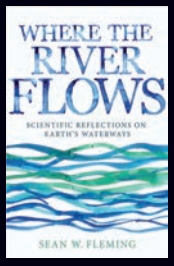
This issue of Elements is a sample of the research and programs in the College of Earth, Ocean, and Atmospheric Sciences that are dedicated to understanding and protecting freshwater resources, here in Oregon and throughout the world. We are excited to welcome to our faculty two more researchers in this arena — **Pamela Sullivan**, a hydrogeologist who studies interactions among climate, vegetation and geology within freshwater systems; and **Mark Raleigh**, a geographer who uses remote sensing techniques to study snowpack. They join a community of forward-thinking CEOAS scientists who are taking a watershed view of today's toughest challenges — drought and disaster risk, disappearing snowpack, diplomacy between shared basins and more. Their work is transforming knowledge of our landscapes and people, inspiring solutions toward a future that is water-rich and equitable.

No matter the scope or angle, the stories here compel us to appreciate every turn of the tap, every dip in a cold stream, every bite of food grown by rain or river. They are a reminder of the shared current between water and our own lives. Enjoy.

Roberta Marinelli
Dean, College of Earth, Ocean, and Atmospheric Sciences

CEOAS bookshelf

Looking for some good reading on a watery topic? We've got three perfect suggestions for you from CEOAS-associated authors:

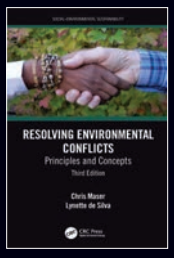


Where the River Flows: Scientific Reflections on Earth's Waterways

Sean Fleming, courtesy faculty and alumnus

Princeton University Press, 2017

How do rivers work? Why do they run where they do, how can they flood one year and dry out the next, and how do we predict their behavior? Fleming explores these questions through metaphor, yet he always bases his analyses on sound science. He crosses disciplines with ease, placing rivers within contexts of landscapes, ecosystems and society.

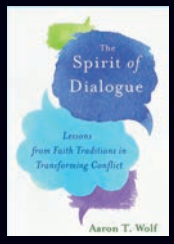


Resolving Environmental Conflicts: Principles and Concepts, Third Edition

Chris Maser and Lynette de Silva, Water Conflict Management Program director and senior instructor

CRC Press, 2019

Maser and de Silva's book is a blueprint for resolving environmental conflict, including water conflict, using a framework based on collaboration, mutual respect and a desire to foster healthy human relationships that can provide a better future for the planet. The volume is steeped in theory but provides practical guidance for ensuring social-environmental sustainability.



The Spirit of Dialogue: Lessons from Faith Traditions in Transforming Conflict

Aaron Wolf, professor

Island Press, 2017

Aaron Wolf has spent decades working to understand the complex scientific, societal and cultural motivations that form the basis for transboundary conflict. In this book, he turns his attention to the traditions of world religions that underpin these motivations and may be used to promote peaceful resolution of challenges surrounding transboundary water allocation.

Bringing beavers back:

Can beaver dams restore western watersheds?

Consider the beaver: Adorable, industrious, ingenious, so beloved in Oregon that we are proud to call ourselves the Beaver State. The race to trap them two centuries ago for their valuable pelts was central to the development of the Pacific Northwest and played a critical role in U.S. history. And of course, Oregon State University has a thing for beavers.

Sadly, Beaver Nation, our fuzzy mascot is not universally beloved. Between the fur trade and removal to combat dam-induced flooding, the beaver population is significantly reduced from historical numbers. Today, many landowners throughout the west consider them pests.

Now, groups interested in river restoration are trying to bring beavers, or their dams, back to certain Northwest landscapes. Beaver-related restoration, also known as BRR, is gaining traction as a method to restore deeply incised streams — those that chisel through the terrain, creating mini-canyons with steep banks.

BRR can mean plugging up streams with structures that mimic beaver dams, creating conditions under which beavers will return to the landscape and build dams themselves, or even relocating actual beavers to restoration sites. The hope is that these approaches will encourage the incised streams to rise behind dams, reconnecting them with their flood plains and restoring streamside meadow habitats that originally blanketed parts of the Northwest.

An interdisciplinary team of Oregon State faculty and students has been studying the successes and challenges of this approach. The team is trying to bring analytical eyes to a process that inflames passions, both pro- and anti-beaver.

For advocates of BRR, some so fervid that they have been called Beaver Believers, the "nature-healing-nature" aspect of this approach is tremendously attractive. And there are certainly examples of successful BRR projects. The Oregon State team has examined one on private land south of John Day, Oregon, called Silvies Valley Ranch. Property owner (and OSU alumnus) Scott Campbell built what he called artificial beaver dams made of rock and asked **Gordon Grant**, a fluvial geomorphologist with the College of Earth, Ocean, and Atmospheric Sciences and the U.S Forest Service, to take a look.

Indeed, Campbell's approach raised the creek, reconnected it to its flood plain and brought riparian meadows back. "I've never seen anything as effective as what he's done," Grant says. "The magnitude of change is on the same order as the change that came with the incised streams, and his restoration was much cheaper than other methods."

But, Grant warns, this approach might not be practical for other locations. Considerable uncertainty remains around the criteria for successful projects, and issues of appropriate governance, including which permits to procure and from whom, are as fuzzy as the beavers themselves.

Hannah Gosnell, a CEOAS professor who focuses on human dimensions of environmental issues, and recently graduated master's students, **Rachael Davee** and **Zach Pike-Urlacher**, are particularly interested in these governance structures and other human dimensions of BRR. "Some of the legal and institutional mechanisms in place to address other types of environmental restoration haven't really kept up with the idea of using beavers to restore watersheds," Gosnell says. "We're asking: How do you create the right policies and laws and institutions to support this nature-based solution? A beaver that moves around is much more complicated than a log or other static structure you put in the river."

With Gosnell's support, Davee and Pike-Urlacher analyzed a number of BRR case studies, conducting extensive formal and informal interviews with stakeholders. Pike-Urlacher characterized emerging governance structures, finding that one of his study sites, the Upper Nehalem Watershed, was more advanced than others with respect to adaptive governance on the BRR issue. "They are taking a more grassroots approach, rather than a top-down approach, using network formation and supporting 'bridging organizations' at multiple levels of government to address BRR issues," he explains.

The Oregon State team is concerned that some of the BRR enthusiasm needs to be tempered with a greater understanding of the goals of each project and the criteria for success. Gosnell and Grant are co-authors on an upcoming paper that explores whether BRR generally achieves its goals. Grant's recently graduated Ph.D. student, **Caroline Nash**, now at Boise State, is the lead author on the paper.

Nash points out that at every step of the flow chart of a BRR project, there are assumptions that must be met for success. Does the dam stay in place? If so, does it accumulate sediment at a meaningful rate? If it does both of those things, does the dam survive storms or flood events? "As you go down this list, the reliability of your outcome becomes a lot more site-dependent and dependent on success of the previous steps," Nash says.

Nash notes that many successful BRR projects take a multifaceted approach to restoration, instituting land management changes along with BRR. "You may see an operational shift in how they're managing ranching or agriculture, or where they're building roads. Or maybe they're planting a bunch of new species in the landscape," she notes. It can be hard to tease apart what factors led to landscape changes in these cases.

"What we really need to ask," she says, "is how do we manage watersheds with beavers in them? How can we be good biotic neighbors, and how can beavers inspire us to adopt better land stewardship practices?"

If scientific data collection can be built into BRR regulatory requirements, Nash says, scientists, restoration practitioners and managers will build a better understanding of where this unique approach to watershed restoration will work best. Don't be surprised if beavers — and Beavers — are once again making their mark on the western landscape.

A natural beaver dam at Silvies Valley Ranch. Photo: Caroline Nash

Save water by cutting trees?

Julia Jones conducts long-term ecological studies to find out

Thirty years ago, Julia Jones had a cartoon of the water cycle hanging in her office. Not the kind you might think of, with rain feeding rivers, trees intercepting rain, and evaporated moisture vaulting into clouds. Her cartoon showed arrows moving in a circle, connecting the words "Floods-Concern-Drought-Apathy."

Jones, a professor of geography in the College of Earth, Ocean, and Atmospheric Sciences at Oregon State, says the cartoon couldn't be timelier, in spite of its age.

"A couple of decades ago, the big concerns in our region related to hydrology had to do with floods, extreme high flows and the role of dams and forestry in managing those flows," she says.

But now the dialog has shifted to water scarcity, which, as predicted by the cartoon, has raised far fewer eyebrows here in the Pacific Northwest.

Jones is seeking to change that. Her research includes a particular facet of water scarcity, namely the near-invisible ways that trees and water intersect. Her diverse work in this area includes long-term experiments that ask whether natural forests or managed stands use less water.

Cut trees. Save water?

In 2008, Jones and colleagues produced a National Academy of Sciences report that outlined the hydrological effects of a changing forest landscape. The report was prompted by a question that some U.S. government agencies were asking: Can you save water by cutting trees? In the face of drought, the question seemed innocent enough. Forests use a lot of water, so thinning thirsty trees could increase water yield.

The NAS report revealed some key points. Among them was that reduced forest cover may increase water yield, but increases are generally short-lived and occur during seasons of water excess rather than scarcity. The report also called for additional research to understand how climate change, forest management and water quantity and quality may interact over longer time scales.

Fortunately, Jones has been on the front lines of conducting long-term ecological studies at the H.J. Andrews Experimental Forest in Oregon. She and graduate student **Timothy Perry** recently published a paper that examined 60 years of watershed data at both the Andrews and South Umpqua Experimental Forest, comparing water use between old-growth forests and forest plantations. They discovered that although initially there was a short-lived increase in streamflow after old forests were logged, plantation forests beyond the age of 20 years used twice as much summertime water as old-growth forests.

"That implies that in the Pacific Northwest region, as we have converted older forests into intensively managed plantations, we are having an effect on a public good — water in the summertime — and we are still in the apathy part of the water cycle, because there isn't awareness of this effect," Jones says.

Old-growth trees: water savers

Exactly why old-growth forests use less water during the hot, dry summers typical of our region is both fascinating and complicated. It may in part have to do with epiphyte communities — the ferns and mosses growing on the trees. These communities can take centuries to develop.

"The old-growth associated epiphytes have a greater capacity to store water and release it more slowly," Jones says.

An even closer view reveals the little-understood role of endophytic fungi — fungi that live symbiotically with trees, growing inside coniferous needles. Scientists once thought that coniferous trees cannot absorb water through their needles. But these fungi may have the ability to draw in water.

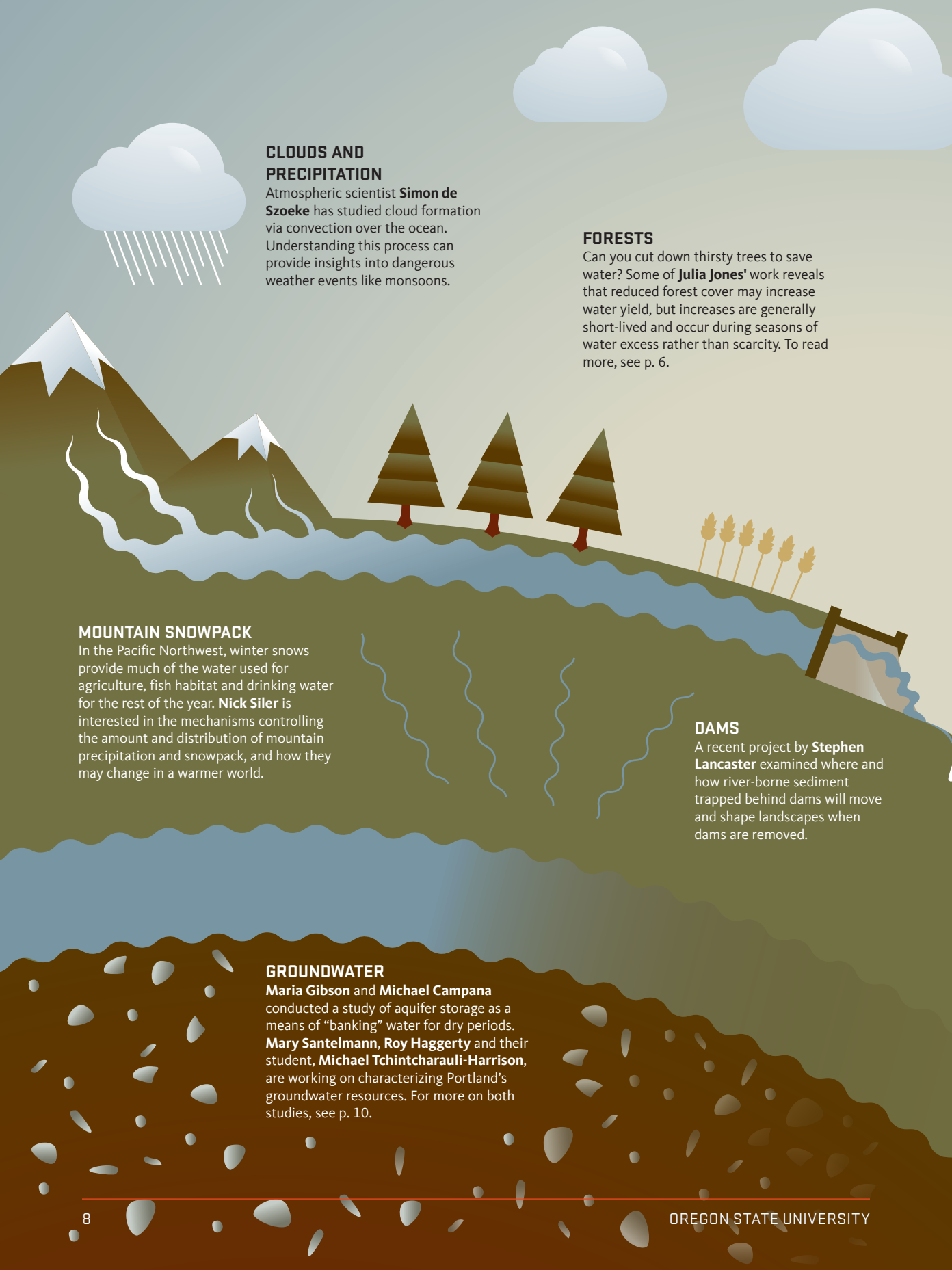
Another mechanism for water retention in the forest is the microclimate created by the canopy itself, which Jones and colleagues investigated in the Andrews. On warm days, sun hits the canopy and heats the air. The air rises, water evaporates and the wind moves the air up the valley and upslope. But, as soon as part of the landscape becomes shaded, the air cools and descends.

"The Andrews is never less than 20% in shade. Even on the hottest days in 2017 when temperatures reached 106 degrees, in the early afternoon, the tall, old-growth trees and steep slopes cast shadows that cooled the air, which flowed downward and carried water vapor back down the valley. There, the water vapor condensed on the tree tops during the night. These processes of cold air drainage are accentuated by the steep topography and the presence of tall trees," Jones explains.

Ecological surprise

With growing international recognition of the connections among forests, water and people, Jones is hoping that the needle is moving from "apathy" about drought to "concern." Her long-term research at the H.J. Andrews is central to raising awareness on the unimagined ways that trees and water intersect.

"After 40 years of funding from NSF, one of the most important lessons of long-term ecological research is the ecology of surprise," she says. "A colleague of mine describes two different kinds of surprises. One is when a finding challenges a theory. The other is when you discover something that you never could have imagined, and you experience amazement and wonder. At the Andrews, we have a lot of the second kind of surprise. We never could have imagined that a system worked this way, until we started looking at it for a long, long time."



CLOUDS AND PRECIPITATION

Atmospheric scientist **Simon de Szoeke** has studied cloud formation via convection over the ocean. Understanding this process can provide insights into dangerous weather events like monsoons.

FORESTS

Can you cut down thirsty trees to save water? Some of **Julia Jones'** work reveals that reduced forest cover may increase water yield, but increases are generally short-lived and occur during seasons of water excess rather than scarcity. To read more, see p. 6.

MOUNTAIN SNOWPACK

In the Pacific Northwest, winter snows provide much of the water used for agriculture, fish habitat and drinking water for the rest of the year. **Nick Siler** is interested in the mechanisms controlling the amount and distribution of mountain precipitation and snowpack, and how they may change in a warmer world.

DAMS

A recent project by **Stephen Lancaster** examined where and how river-borne sediment trapped behind dams will move and shape landscapes when dams are removed.

GROUNDWATER

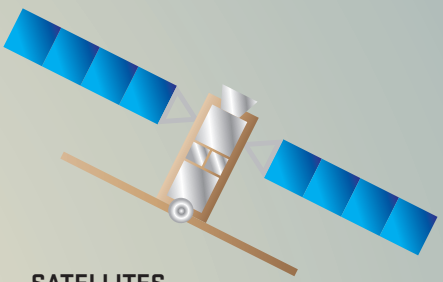
Maria Gibson and **Michael Campana** conducted a study of aquifer storage as a means of "banking" water for dry periods. **Mary Santelmann**, **Roy Haggerty** and their student, **Michael Tchintcharauli-Harrison**, are working on characterizing Portland's groundwater resources. For more on both studies, see p. 10.

WATER WORLD: MAKING DISCOVERIES TO PRESERVE OUR MOST PRECIOUS RESOURCE

When it comes to protecting and understanding one of our most vital resources — water — CEOAS researchers investigate everything from clouds to groundwater. Below is a sampling of the freshwater research projects churning away in the College of Earth, Ocean, and Atmospheric Sciences.

DROUGHT

David Wrathall and **Jamon Van Den Hoek** are geographers interested in human migration in response to environmental stressors such as drought. In a recent analysis, they determined the link between water stress and migration is currently understudied in places like India, Central Asia, the Middle East and the Central Sahel.



SATELLITES

New faculty member **Mark Raleigh**, arriving in August of 2020, is an expert in remote water sensing. His research examines the role of snowpack processes in the water cycle to improve understanding and prediction of hydrology in snow-influenced watersheds.

WATER DIPLOMACY

A recent project spearheaded by **Aaron Wolf** identified hotspots of potential future hydro-political tension. The basins most vulnerable to conflict, Wolf found, are those where new water infrastructure is being built or planned, but formal transboundary arrangements are absent. **Lynette de Silva** recently published a book chapter outlining the critical role of women in transboundary water dispute resolution.

RIVERS

New faculty member **Pamela Sullivan** studies how the interactions of climate, vegetation and geology affect freshwater resources, from the shale catchments of central Pennsylvania to the Florida Everglades.

Graduate student Michael Tchintcharauli-Harrison uses modeling and isotopic analysis to better characterize some of Portland's groundwater resources.

Notes from underground:

Groundwater research focuses on the water beneath our feet

Groundwater provides about 40% of public supply and about 39% of agricultural water in the United States, according to the U.S. Geological Survey. Several faculty and students in the College of Earth, Ocean, and Atmospheric Sciences focus their research on groundwater issues in the Pacific Northwest; here are two noteworthy projects that could change how this precious resource is managed.

Supplementing storage using managed aquifer recharge

Here in the lush Pacific Northwest, climate change has meant that crucial winter precipitation has often been falling as rain rather than snow. As a result, snowpack and spring melt are diminished, sometimes leaving the region with a water deficit during the spring and summer months, just as thirsty crops and people, and migrating salmon, need that water.

What if we could store that winter river flow for when we really need it? Some places already do, using managed aquifer recharge. Rather than storing water in a surface reservoir, where it is subject to evaporation, MAR uses a variety of methods to store water in aquifers and pump it out on demand.

Maria Gibson, a former Ph.D. student and current post-doc working with CEOAS' **Michael Campana**, is an expert on the regional use of MAR. Her Ph.D. project examined opportunities for MAR in Washington's Yakima River Basin. According to the U.S. Geological Survey, the basin is one of the most intensively irrigated areas in the United States. Its water resources are stretched thin due to high demand by municipal, fisheries-related, agricultural, industrial and recreational uses. Managers are diligently looking for new approaches to water storage that will enhance the ability to provide water throughout the year.

Gibson's project assessed suitable locations for aquifer recharge by examining a range of factors including land use, topography, characteristics of the bedrock, transmissivity (the rate of flow of water from surface to aquifer) and depth to the aquifer's surface. This work was conducted using a wide range of tools: satellite imagery, geologic maps, owner tax lot information and more.

She eliminated areas where satellite imagery revealed that water pools at some times of year, suggesting that groundwater was already filling up underground space and reaching the surface.

Next, Gibson used a mathematical model to determine how much water could be stored in identified priority areas. “I looked at 20 years of stream gauge data from the Yakima River to ask, if we had been undertaking this kind of storage, how much water could we have stored each year? Which locations would work best?” Gibson explains. This part of the model was also used to determine how climate change might affect storage.

Gibson and Campana then used this information to develop specific site recommendations for groundwater storage in the basin, which are now being considered by regional water resource managers. Using MAR at these sites is likely to give the managers much more flexibility and capacity for water storage in this region.

Continuing her interest in water and society, Gibson’s post-doc project also focuses on groundwater, this time mixed with economics. In many places, chemical contamination and other environmental impacts have rendered aquifers unusable. She will develop methods for translating lost aquifer capacity into dollar figures in order to evaluate the economic effects of environmental degradation of aquifer sites.

Isotopes and modeling: Tools for studying Portland’s groundwater

Groundwater can also be an important resource in urban areas. Portland, for example, gets most of its drinking water from the Bull Run Watershed 30 miles east of the city. However, in dry years, the city turns to its secondary water supply, a set of aquifers in northeast Portland abutting the Columbia River, collectively called the Columbia South Shore Well Field.

Ph.D. student **Michael Tchintcharauli-Harrison**, advised jointly by CEOAS’ **Mary Santelmann** and College of Science Dean **Roy Haggerty**, is passionate about urban water resource issues. To better characterize some of Portland’s groundwater resources, Tchintcharauli-Harrison is using two techniques: isotopic analysis and modeling.

Stable isotope analysis allows researchers to take a “fingerprint” of a water sample by examining the ratio of isotopes of hydrogen and oxygen, which vary depending on the water’s source. This analysis allows Tchintcharauli-Harrison to ask questions about the groundwater’s origin and flow path, and helps illuminate interrelationships between groundwater and surface water. For example, he can take a sample of Portland water from a tap, run an isotopic analysis on that sample, and determine the original source, whether from an aquifer or a reservoir. “Being able to determine how the city uses its water and how those sources change throughout the year is key,” he says.

He is also constructing a new model of groundwater/surface water interaction to determine how effectively certain water management infrastructure diverts runoff from city streets to groundwater. He has mapped thousands of these infrastructure points and will run the model to determine how well they take water off the streets under various rainfall scenarios. The model will provide invaluable information for planners on how to build water management infrastructure that helps control flooding in a wet place like Portland.

Yakima River, Washington.
Photo: Gregg M. Erickson

With support from the Rotary Foundation International, 11 students — including several from Central Asia — participated in the Water Cooperation and Diplomacy joint graduate program.

Across the aisle:

International program in water cooperation builds conflict management skills

Throughout the world, more than 250 river basins are shared between two or more nations. These basins, called transboundary watersheds, account for almost half the land surface of the Earth. Shared waters can be sources of intense conflict and tangled water treaties, if there are treaties at all. Upstream countries may build a dam, for instance, disrupting everything from the amount and timing of water available, to the cultural traditions intimately tied to rivers for downstream nations.

Managing water in these transboundary basins requires understanding both science and diplomacy. And yet, water managers often lack formal training in the latter. Seeing an opportunity to fill a gap, Professors **Aaron Wolf**, **Mary Santelmann** and colleagues at Oregon State University partnered with the University for Peace in Costa Rica and IHE Delft in the Netherlands to organize a joint graduate program in Water Cooperation and Diplomacy. Launched in 2015, the program aims to broaden the approach to conflict and peace, create a global context for water diplomacy, and strengthen skills through highly experiential learning opportunities.

"We really emphasize that the hydrology, the science, the things we can measure go hand-in-hand with the diplomacy, with the conflict management skills, with the ways we can have better conversations around shared values so that these kinds of basins can be managed in a way that benefits everybody," Wolf says.

This year, a cluster of students, including seven from the Aral Sea Basin in Central Asia, received financial support from the Rotary Foundation International. Central Asia is of particular interest from a water cooperation standpoint, since the region has experienced major changes in social, political and environmental conditions in the past half-century.

"The Aral Sea Basin is one of the more complicated transboundary watersheds, both from a hydrological and

hydro-political standpoint," Wolf explains. For decades the Aral Sea has been shrinking, with water siphoned off by diversion projects faster than rivers can replenish it. High salinity levels and toxic waste are other issues. And most complicated of all, several surrounding nations — including Uzbekistan, Iran and Afghanistan — have a stake in its management. The goal is that the newest student cohort will help build additional capacity in water diplomacy and peace in this complex region.

The 2018-19 cohort first spent time at the University for Peace in Costa Rica, developing foundational skills in conflict studies, water security and peacebuilding strategies. At IHE Delft, they took coursework in water governance and conflict management. During their final leg at Oregon State, the students brought their skills into focus toward a project or thesis.

Some students examined water education or aging water infrastructure, others focused on groundwater decline, contamination, the dynamics of power and gender, or drafting treaties and managing the competing concerns and values of surrounding Central Asian nations.

Mary Santelmann, the director of the Water Resources Graduate Program at Oregon State, has been closely involved in the administration, advising and instruction for the joint program. She stresses that the goal is not to impose a Western view of water management on these students, but rather to enhance their already-strong water management toolkit and foster cooperation and conversation among students in the cohort.

"We want to build on the experiences and professional capabilities that the students already have," she says. "We hope that when they return to their home countries, the relationships they have formed with their colleagues will allow them to transform conversations about how water is managed in their region, and to build peaceful solutions in areas where there are multiple opportunities for conflict."

The students are already on their way. **Botagoz Sharipova** from Kazakhstan is eager to apply the lessons of cooperation she developed throughout her time in the program. "At the moment, there is enough water in Central Asia for all. Once we understand that, the main thing we should strive to achieve is cooperation among all the countries and at all levels – at national and regional scales for all water users," she says.

No matter where they end up, the students have given back to the program in unexpected ways, says Santelmann, inspiring their peers and even teachers to rethink approaches to water conflict. "These students are not just learners but teachers," she says. "They are teachers for one another, and in many ways, they are teaching us about conflict management."

Game on: Fatima Taha tackles water conservation through serious gaming

Originally from The Sudan, Fatima Taha grew up in the United Arab Emirates and earned a bachelor's in civil engineering, a post-graduate diploma in shared water resources and a master's degree in water resources engineering. But even with her impressive scholarly training, Taha felt she was missing a crucial skill. "In order to resolve any dilemma in a pragmatic way, you need to strive for the creative way, and communicate it effectively between all concerned parties. As an engineer, I didn't have that set of mind." So, Taha became one of the first students to go through the joint program in Water Cooperation and Diplomacy. She worked with Todd Jarvis to examine how serious games, or games designed to teach a skill or a specific subject, have been increasingly used as a conflict resolution tool. She developed her own serious game called Conserve Oregon, which inspires players to solve water issues related to historical events in Oregon. Her idea won first place at Oregon State's 2017 Hardware Weekend competition, which challenges teams to create and pitch a marketable project in a single weekend. Taha is now working for the Water Cooperation and Diplomacy program while earning her Ph.D. in geography at Oregon State.

At the boundary:

Racquel Rancier brings together people and policy to manage Oregon's water

Racquel Rancier earned her master's degree in water policy and management in 2012, working with Professor Aaron Wolf to examine tribal water rights. After graduating, she worked for the Oregon State Legislature and then became a senior policy coordinator with the Oregon Water Resources Department. We caught up with Rancier to learn about her career path, the challenges of water management in Oregon and the must-have skills for the field.

You grew up near Los Angeles, a place that has a very complicated history with water. Did this fact influence your career path?

Yes. I grew up in a small rural town about 70 miles northeast of Los Angeles. As a kid, I would pass the Los Angeles Aqueduct Cascades, which takes water almost 200 miles from the Owens Valley to Los Angeles. Owens Lake used to be the largest lake by surface area in the United States; now it is mostly dry — a conflict written about in many books, including "Cadillac Desert." Little did I know that this site, among many others, would lead me into the water policy realm.

You weren't always in water resources, though. You worked in TV! How did you make that transition?

Yes, many people are surprised to hear that I used to work for E! Entertainment Television and G4. I didn't actually watch TV that much. While my coworkers read the latest celebrity news, I was reading about the California Bay-Delta. I was fascinated by the water challenges there, as well as in the Klamath Basin, Owens Valley and Los Angeles. I found volunteer opportunities and attended a couple conferences, including the UNESCO World Water Conference. I took tours of water facilities, interviewed professionals and networked pretty well for an introvert! From there, I applied to and was accepted into graduate programs at Oregon State University and UC Santa Barbara. Obviously, I chose Oregon State!

Is there any such thing as a typical day for you?

No. My position requires me to know a little about a lot, and to know what questions to ask to help us make decisions. Some days, I have to dive deep into groundwater science and the corresponding laws and social dynamics. I also write or edit a lot of the external materials and am the press contact for the agency. I testify before the Water Resources Commission and Legislature on a regular basis, and have to quickly assess whether legislation impacts our agency or water resources.

You've been involved in some interesting legislation, including a bill that would improve dam safety. Can you tell us about this bill?

Oregon's dam safety statutes have been essentially unchanged since 1929. And yet, our dams are aging. We also have increased understanding of seismic risks, flood potential and internal erosion. Even with knowledge of these potential hazards, we had to wait for a dam to be unsafe before we could require the owner to act. So, the department introduced House Bill 2085 during the 2019 legislative session. The bill created a cooperative program to work with owners of dams — noting the huge costs associated with repairs and the importance of dams in storing water — while also balancing the need for action because of the risks to people and property.

As we look ahead to population increases, climate change and other water stressors, do you see your job changing in the future?

Yes. Water management is getting increasingly complex. For example, the Klamath Adjudication began in 1975, and the issues there are still unresolved — and that is not unique. But I would argue that these issues take time because they are important and get at the very core of our beings. We need water for drinking and sanitation, for the energy we use, for the food we eat, for the landscapes we love, and the life and species we value. Yet there has been insufficient investment in water data, infrastructure and management. We also need more efforts to engage the public and make information accessible. We need data, but we also need to facilitate conversations, bring people together, build trust, distill really complex science and data, and help find a path to move forward.

What advice would you give someone trying to enter your field?

In the water field, you have to persevere, because there are no easy solutions. Confidence, humility and gratitude are all musts. This may seem contradictory, but when you rely on so many others within and outside of an organization, they are all important.

If I am giving career advice, regardless of the field, I often tell new professionals:

1. Hone your written and verbal communication and conflict resolution skills.
2. Do informational interviews and job shadows to meet people in the field and to better understand various career paths.
3. Do as many internships or volunteer positions as possible to build your résumé and help you gauge whether you would enjoy a particular job.
4. Career paths are often nonlinear, and everyone has to get started somewhere! Don't be afraid to try new things.
5. Always try to develop as many skillsets as you can, as you never know what opportunities they will open for you.
6. Have someone review your résumé, and make sure it is easy to read.
7. Maintain good relationships with your coworkers, professors and employers. Be the first to apologize, the first to forgive and the first to own up to your mistakes.

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