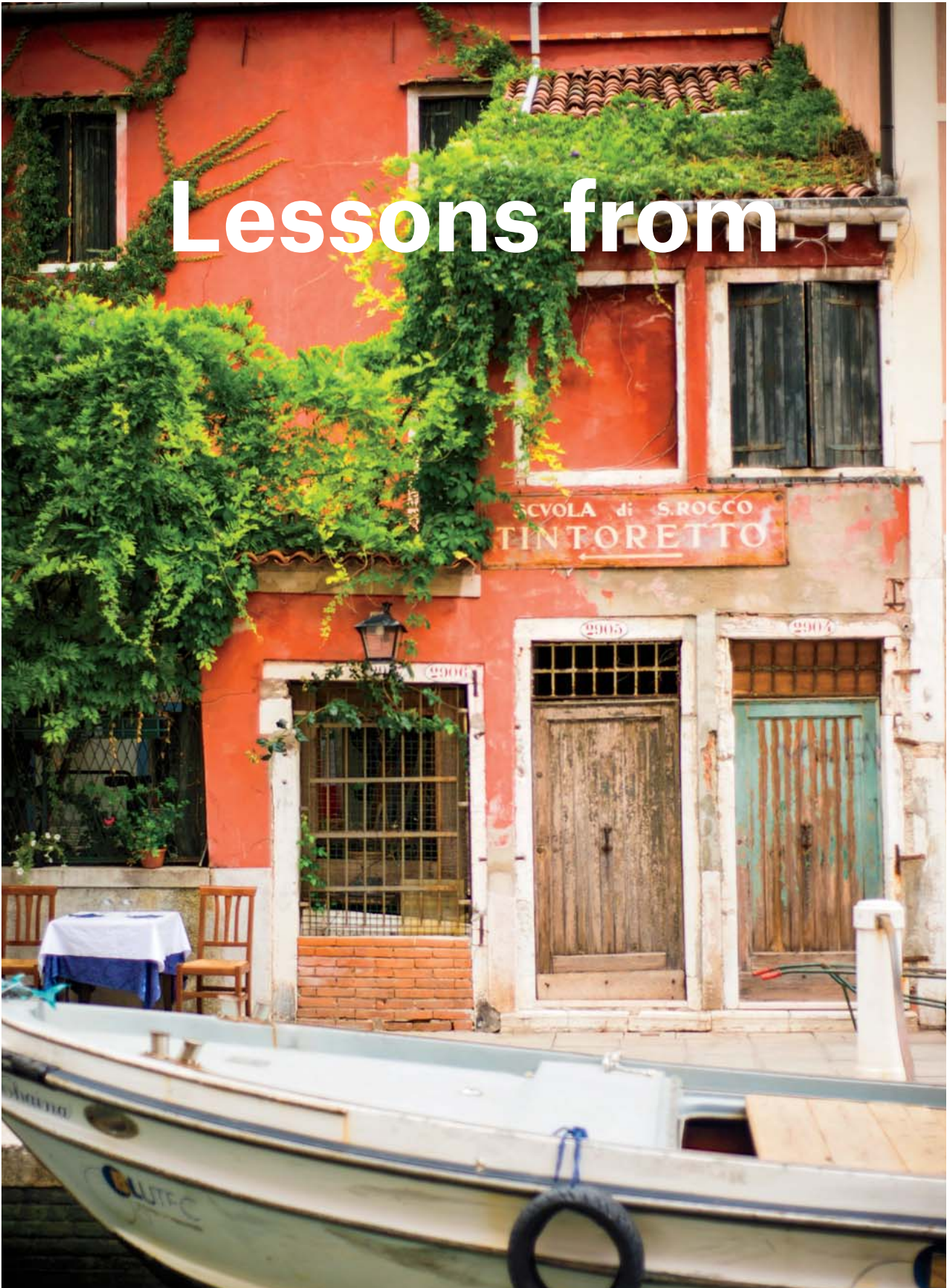


Lessons from



Venice is one of the first major cities to go to war against a sea swelled by climate change. Its strategy is a model for dozens of cities around the world, and the topic of a new BU course.

BY AMY LASKOWSKI

Venice





ON A WARM JUNE NIGHT, tourists sip cocktails on the banks of the Grand Canal. The surface of the canal shimmers, reflecting the lights of 14th-century palaces, now home to art galleries and wine shops and condos. Suddenly, a police boat speeds by, and a maintenance man a few docks down motions frantically for the tourists to move. They ignore him, and a few seconds later, the wake from the speeding boat soaks their elegant skirts and shoes. Welcome to Venice, in the summer of 2014.

Venetians have always lived with the water—the city is built on islands, and canals do in Venice what streets do in other cities. Recently, however, as global warming pushes sea levels higher, the water in Venice is more threatening than it's ever been. A recent warning from the Intergovernmental Panel on Climate Change, an international scientific body that operates under the auspices of the United Nations, projects that sea levels around the world

In the 1950s, St. Mark's Square, the lowest point of Venice, flooded about 20 times a year. These days, the historic tourist spot floods 60 times a year.

could swell by more than three feet by the end of this century. In Venice, a World Heritage Site, a centuries-old struggle to stay one step ahead of the rising tide has taken on a new urgency, as scientists predict that the city could be underwater in less than a century.

For those who study climate change, the City of Water has become a living laboratory, a cautionary tale, and an ideal teaching tool. This summer, the new Venice Environmental Studies Program, organized by BU Study Abroad, brought students to Venice for six weeks to learn how scientists and policy makers are working together to find solutions, and how their findings might be applied to the many cities around the world that will someday face the same water-logged fate.

"Boston, Hong Kong, New York are all at risk," says environmental science major Danielle Pelletier (CAS'15).

As if the rising water weren't enough of a problem, Venice suffers from shifting plate tectonics, meaning the ground underneath the city is sinking. Venice settles at a rate of about four inches per century.

“Venice is one of the first cities learning how to deal with this; it’s among those taking the first steps to adapt to sea level rise. These adaptations may be something that turns out to be effective and used worldwide.”

IN THE BEGINNING, THERE WAS MUD

The first Venetians chose to settle in a mosquito-filled marsh in the northern Adriatic Sea. These fifth-century settlers were fleeing German and Hun invaders and probably picked the area—dozens of islands surrounded by a 200-square-mile shallow lagoon—for the protection it afforded.

They built their city by driving giant wooden poles 10 to 15 feet into the ground, effectively petrifying and preserving them. They put planks on top of these pillars, and marble foundations on top of the planks. In time, as rivers deposited silt on the islands, Venetians found it necessary to redirect

the rivers, aiming them at the sea instead of the lagoon. In *Venice Against the Sea: A City Beseiged*, author John Keahey writes that if the Venetians hadn’t changed the natural landscape, this area would have filled up over the centuries and eventually become Italian coastline.

Scientists believe that beginning in the fifth century, the sea level in Venice increased at an average rate of five inches every century, according to Keahey. Archaeologists have found signs that ancient Venetians gradually raised the ground level as high as six feet. In St. Mark’s Square, the lowest point of Venice and home to St. Mark’s Basilica and the Doge’s Palace, there are five levels of older pavement beneath today’s plaza.

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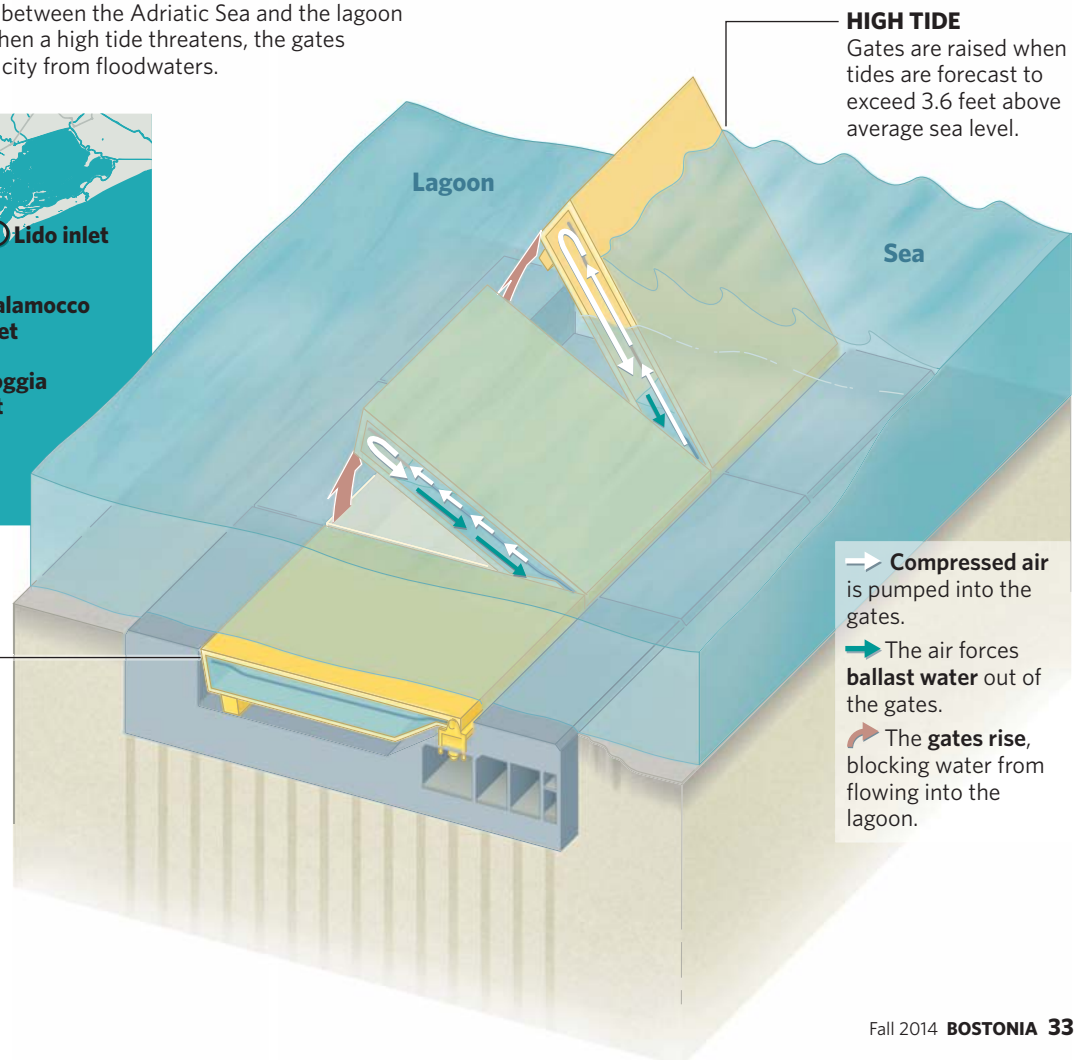
Protection from the sea

The \$6.7 billion MOSE project includes a series of steel gates installed at three inlets between the Adriatic Sea and the lagoon surrounding Venice. When a high tide threatens, the gates will rise, protecting the city from floodwaters.



NORMAL CONDITIONS

The gates are filled with water, holding them in place in their housing structures on the lagoon floor.





Ecologist Sonia Silvestri says salt marsh vegetation plays an important role: salt-tolerant plants, called halophytes (see facing page), trap and stabilize sediments in the marshes.

1970s, industries in the area recklessly pumped groundwater for use in their plants, a practice that speeded the city's drop of five inches in the last century. The sinking has subsided significantly in the last few decades, and now Venice is settling at a rate of about four inches per century. The effects of global warming are most evident in St. Mark's Square. In the 1950s, the historic tourist spot would flood around 20 times a year, says Keahey; today it is submerged 60 times a year.

THE LAGOON AS A CLASSROOM

At 9 a.m. on a Monday, four students and their professors in the Venice Environmental Studies Program clamber aboard a speedboat, lugging backpacks filled with water, sunscreen, and bug spray. The previous night was a late one for almost everyone in Venice, as most of the city stayed up to feed an obsession with World Cup soccer. The day trip takes the students to Venice's flood barrier system, the Modulo Sperimentale Elettromeccanico (MOSE), its name a nod to

Moses, who parted the Red Sea (in the nick of time). Two years away from completion, the MOSE system is a series of mobile gates installed at Venice's three inlets and spanning nearly a mile. In calm weather, the MOSE gates will sit at the bottom of the lagoon. But when a storm with an *acqua alta*—exceptionally high tide—threatens, the bright yellow steel gates will rise within 30 minutes to protect the lagoon from tides of up to 10 feet. It is expected that the gates will stay up from four to five hours.

After a 40-minute ride, the BU boat pulls up to one of the MOSE inlets, where heavy machinery is chugging away.

With the engine turned off, instructor Sonia Silvestri stands so the class can hear her. The MOSE system is controversial, she explains, mainly because of its cost: more than five billion euros (\$6.7 billion). The project, run by Consorzio Venezia Nuova, a consortium of engineering firms, has also been plagued by delays. In June, Venice's mayor resigned amid allegations that he had received funds for his 2010 mayoral campaign from some of the companies building the MOSE.

An ecologist, Silvestri prefers to focus on how the MOSE will affect the lagoon's already delicate ecosystem. When the MOSE gates are up, she says, the flow of seawater entering the lagoon will be interrupted, and that will affect water quality and temperature. The closed gates will also mean the lagoon can't clean itself, and sewage—which pours into the canals and then moves to the lagoon—will remain longer.



The severity of the problem becomes clear when the students learn that Venice does not have a modern sewer system, so that sewage from homes, along with pollution and runoff from industrial areas and local farms, ends up in the lagoon. These problems will only worsen, Silvestri says, as rising sea levels will force the gates to close more frequently.

From Silvestri's perspective, if the MOSE is to be successful, it needs to be complemented by projects that will restore the lagoon's natural structure and build up its natural defenses. Some of these measures, already under way, include improving water quality by dredging the canals, which improves the water exchange in the inner lagoon areas, securing runoff from dumps and industrial areas, reinforcing the seawalls surrounding Venice's islands and canal banks, and restoring the area's salt marshes.

The boat's next stop is a salt marsh, a natural environment that increases the amount of organic material in the soil and filters pollutants. Many of the plants found in

SAVING THE US COASTLINE



According to the National Ocean Service, 123 million people, or 39 percent of the US population, lived in shoreline counties in 2010. The number of coastal dwellers is expected to increase by 10 million, or 8 percent, by 2020. Following Hurricane

Sandy, the Obama administration made coastal sustainability research a priority. In June, President Barack Obama earmarked \$1 billion for national disaster resilience, and the National Science Foundation promised \$670 million toward programs dealing with coastal sustainability and climate change research.

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healthy salt marshes slow erosion, because their roots bind together the sediments. The boat stops at the island of Lazzaretto Nuovo, the site of a 15th-century fort that was used to quarantine ships entering the Venetian port. Today the island is largely uninhabited, surrounded by marshes, and an example of the kind of land that the ancient Venetians built their city on—mucky and marshy.

Enrica De Cian, an instructor who taught the program's course on the economics and policy of climate change, leads the class down a path toward the sea. She is careful to step on the tall green reeds to avoid sinking in the muck.

Today's lesson is about the role that salt marsh vegetation plays in this ecosystem. Silvestri explains that salt-tolerant plants, called halophytes, trap and stabilize sediments in the marshes. "Some people call it sea asparagus," she says, plucking a salt-tolerant salicornia plant from the ground. "You can find it in fancy Venetian restaurants alongside fish; it's spicy." The students hesitantly take a bite—it tastes like a scallion. This is a pioneer species, Silvestri says: if this plant is growing, other species will start growing.

CLIMATE CHANGE: IT'S ABOUT SCIENCE—AND MONEY

De Cian wants the students to know something else about climate change: very often people think of it as a matter of science, she says, and while that's true, it's also about money. "The causes of climate change are related to economic activity, and the consequences of climate change have important economic impacts," says De Cian, a researcher at Fondazione Eni Enrico Mattei, an international climate change and sustainable development research center.

A 2013 study in the journal *Nature* estimates that average global flood losses in 2005 across 136 coastal cities were approximately \$6 billion per year. In 2050, the losses are predicted to be \$52 billion a year.

WEB EXTRA
Watch a video about the danger facing Venice at bu.edu/bostonia.

The study warns that we need to act quickly to avoid losses of \$1 trillion or more per year.

In a classroom on Wednesday afternoon, De Cian challenges her students to think about how the MOSE could affect the local economy. Niza Scuderi

(CAS'15) argues on behalf of the Venice Port Authority: the MOSE separates the lagoon from the sea, she explains, so the shipping industry is concerned that it will interfere with boat traffic and port activities. Using a PowerPoint presentation, she shows that 60 percent of boats enter or leave the Venice canal between 6 and 11 a.m., which is, coincidentally, the time of high tide on this particular day.



If an unusually high tide is predicted, the MOSE gates will rise and block a ship from entering or leaving. Delays are predicted to be over an hour. Additional costs now in the mix include potential mooring fees and increased pay for staff. One of Scuderi's proposals is that boats enter the Venice lagoon around the *acqua alta* and the rising MOSE gates.

De Cian says Scuderi's proposal is a good one, because "increased costs and wait times may mean the port authority will have to pay fines, which they would pass on to the consumer." Ultimately, she says,

those costs could make the port of Venice less competitive than other ports.

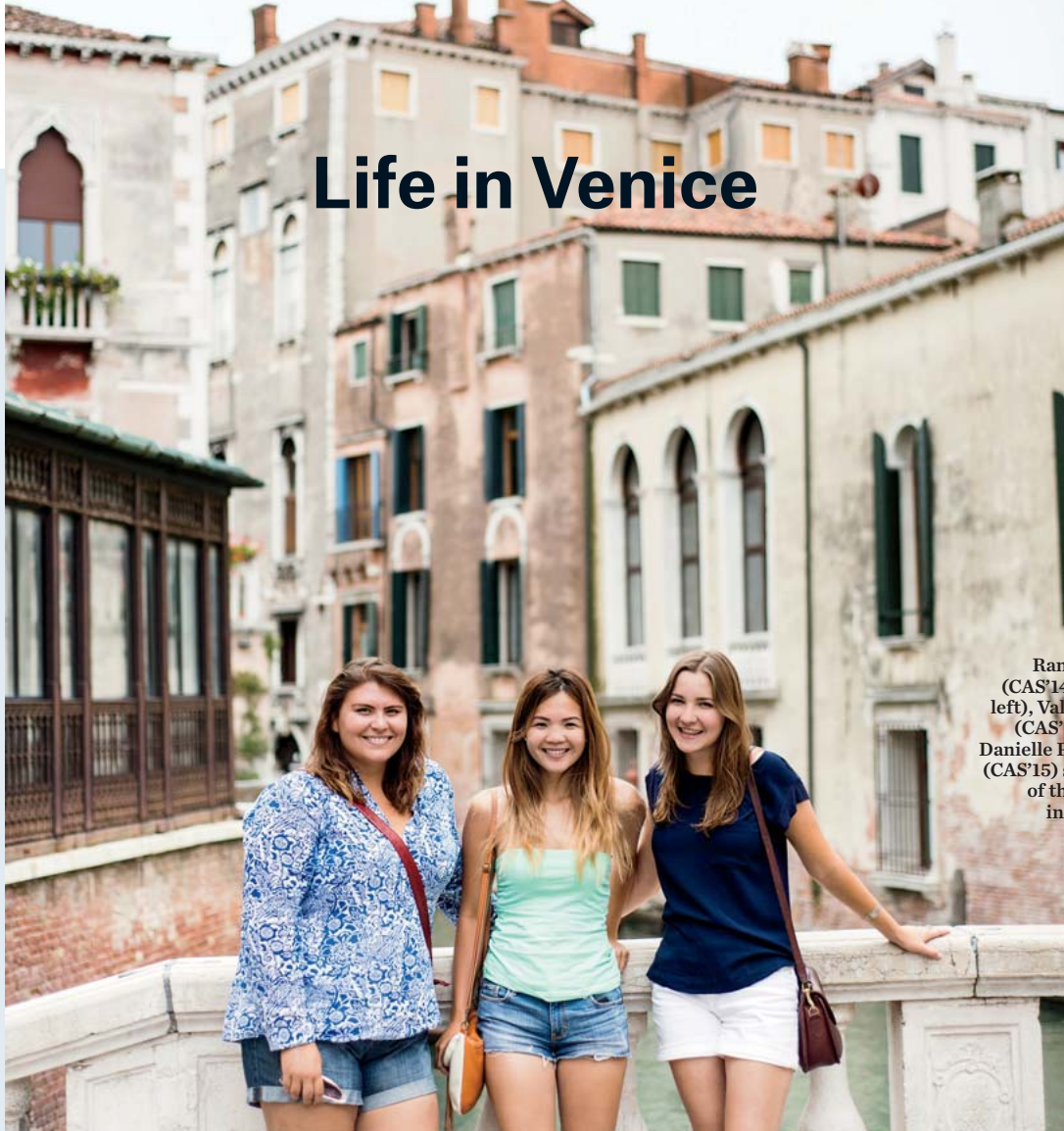
De Cian's research focuses on agriculture, one of climate change's most frequent victims. As the population grows, so will the demand for food. She tells the class that increasing competition for land, water, and energy, in addition to the overexploitation of fisheries, affects the ability to produce food.

The next day, the students tour a water plant and farming community in the Zennare Basin, a below-sea-level area that was reclaimed from the sea during the 1930s and now suffers from both droughts and floods. Farmers in the Zennare Basin have adapted by pumping water out of the fields, but frequent flooding means frequent pumping, which has economic implications, evident mainly in the farmers' energy bills. What's more, the costs associated with lost crops and damages from floods and extreme weather are much higher. "At some point," says De Cian, "farmers might start to consider whether these additional costs they have to pay in order to drain the water can be sustained."

"It's not easy to convince farmers they might want to reinvent, and find something that allows them to make money, maybe fishing," says Silvestri. "You need to find economic advantages for farmers. Maybe it's them opening a fish farm. Maybe they grow salicornia, because it sells for a lot of money in the stores."

Another field trip takes students to the MOSE offices, where they meet with Elena Zambardi, spokeswoman for the Consorzio Venezia Nuova. "The world is looking at the MOSE system," Zambardi tells the students. "New York came here to study if these kinds of systems work for them. They're not interested in the gates, but they may try to construct something else. They care about the salt marshes, because MOSE is an example of a big system with a systematic approach. Tokyo is interested in the floodgate system, a system of defense. We've met with Great Britain, the Netherlands. They ask questions, like which is the best software for management? Everyone is looking to Venice."

Life in Venice



Randi Nees (CAS'14) (from left), Valerie Lai (CAS'16), and Danielle Pelletier (CAS'15) stay out of the water in Venice.

IF YOU have to be in class during the summer, Venice is a good place to be. As the students in BU Study Abroad's Venice Environmental Studies Program were pleased to learn, the city is navigated by boat or foot; cars and bikes are not allowed. Most locals use the vaporetto, Venice's water bus, preferring the cool breezes of the

canal to the winding tourist-filled streets.

Classes typically ran from 9:30 to 11:30 a.m., with a break for lunch, then again from 1 to 2:30 p.m. There was at least one field trip a week. Fridays were class-free, and students used the long weekends for BU-organized trips to the nearby Dolomite Mountains or to Florence.

The BU center is in Venice's Dorsoduro district, and classes were held in a villa on the Rio Dei Tolentini, with expansive win-

dows overlooking the water. The Venice Environmental Studies Program shares the center with the Venice Studio Arts Program, a Study Abroad program for College of Fine Arts students. Most students lived in BU-arranged apartments in the area.

A 10-minute walk from the Dorsoduro is the Gallerie dell'Accademia, where students could see masterpieces such as Leonardo da Vinci's *Vitruvian Man* and Titian's *Pietà*. The Peggy Guggenheim

Collection, with its trove of modern art, is also close by.

The semester coincided with soccer's World Cup, and the matches drew crowds of young people, including American students, to the patios of bars in the Campo Santa Margherita. Many chose to drink the Spritz, a fizzy aperitif that originated in Venice and is made with prosecco, a dash of a bitter liqueur like Campari, Select, or Aperol, and sparkling mineral water. When in Venice... ■