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# University Stormwater Management within Urban Environmental Regulatory Regimes: Barriers to Progressivity or Opportunities to Innovate?

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## Abstract

U.S. public university campuses are held directly responsible for compliance with many of the same federal- and state-level environmental regulations as cities, including stormwater management. While operating as ‘cities within cities’ in many respects, campuses face unique constraints in achieving stormwater regulatory compliance. To compare the abilities of campuses to comply with stormwater regulations to municipalities, we conduct mixed-methods research using primary data from five University of California (UC) campuses. Public universities constituted over 20% of California’s “nontraditional” permittees under the municipal separate storm sewer system (MS4) regulation regime in 2013. We utilize semi-structured interviews with campus and regulatory officials, a survey of campus students and staff around support and willingness to pay for innovative stormwater management, and content analysis of campus stormwater management documents to examine challenges to public university stormwater compliance. We find that, despite their progressive environmental practices in other areas like energy and water conservation, even as compared to cities, stormwater management practices on the evaluated campuses are constrained by several factors: infrastructure financing limitations, lack of transparent and coordinated decision-making, a lack of campus resident involvement, and regulatory inflexibility. Our study provides new insights, both for understanding campuses as sustainable ‘cities within cities’ and more broadly for urban environmental compliance regimes globally.

**Keywords** Environmental governance · Regulatory compliance · University campuses · Stormwater management

## Introduction

This study examines public university campus stormwater management in California in the context of the overall U.S.

urban stormwater regulatory regime, and similar oversight structures operating worldwide. At the broadest level, these efforts support the urban aims of global Sustainable Development Goal 6 for water and sanitation. As “nontraditional”

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stormwater permittees with large populations, campuses are treated as “cities within cities” in that they must comply with similar regulations to municipalities despite having different internal governance structures and capacities. Using a mixed-methods approach to study the five southernmost University of California (UC) campuses, we identify four main obstacles to public university stormwater management as compared to cities. However, we complement these campus-level findings with results from a survey of individual campus students and staff to highlight broad levels of support for more innovative stormwater management, and opportunities for universities to improve campus sustainability within existing stormwater regulations. We first provide background on the structure and timing of stormwater permitting in the U.S. as compared to other countries to help inform our analysis of management on specific campuses.

## Background on Stormwater Management and MS4 Permitting

Amendments to the Clean Water Act added section 402(p) in 1987, creating the foundation for today’s distinct permitting standard for Municipal Separate Storm Sewer Systems, or MS4s (NACWA 2018). The U.S. Environmental Protection Agency (EPA) implements regulations in accordance with the Clean Water Act for MS4s. MS4 Permits were first issued to large cities (population of 100,000 or more) in 1990 (Phase I) and to smaller cities in urbanized areas in 1999 (Phase II) (EPA 2007, 2018). In California, the 2013 Phase II Small MS4 General Permit requires Phase II permittees to develop Stormwater Management Plans (SWMPs) which include Best Management Practices (BMPs) to reduce pollutants to the Maximum Extent Practicable (MEP) (State Water Resources Control Board 2013). For the remainder of this study, MS4 compliance refers to campuses meeting all requirements outlined in Phase II permits.

Most environmental regulation in the U.S. can be viewed as four-levels of principal-agent interactions (federal, state, regional and local) where each successive level tends to pass on enforcement responsibilities (Atlas 2007). In stormwater management, the MS4 process delegates national oversight to state, and then Regional, Water Quality Control Boards (in California) that monitor municipalities and industrial users—a devolved regulatory structure found in other countries.

By comparison, national regulation in Spain occurs at the watershed level in Hydrographic Confederations (Castro-Fresno et al. 2013) while Canada delegates responsibility to provincial governments which administer water quality management agencies (Government of Canada 2017). Australia is most similar to the U.S. but places even more emphasis on sub-national governments. Without binding national standards, the National Water Quality Management

Strategy dictates a collaborative process between national and state governments and most state governments fill the gap with legislation administered through their own Environmental Protection Authorities (EPAs) (Roy et al. 2008). While university campus stormwater management has historically not been directly regulated, the state of Victoria just released new regulations classifying campuses under the same regulatory structure as industrial facilities (reference redacted). As seen in other countries with regionally driven stormwater regulation regimes, the U.S. MS4 permitting process is a truly unfunded and geographically decentralized mandate (White and Boswell 2006; Grigg 2012). A renewal of Phase II permits took place in 2018 that broadened and deepened compliance requirements.

Local governing bodies in the U.S. continue developing best-practices and sustainable compliance strategies for stormwater permitting. Most analyses of these efforts focus on water quality (for example see Boyer and Kieser 2012; Ports 2003), with very few employing an administrative and cost perspective (for one instance, see Garrett 2017). In California, Proposition 218 makes MS4 compliance particularly difficult by making it harder for municipalities to pass new fees, assessments and taxes to fund activities like stormwater compliance (Cousins 2017; California Legislative Analyst’s Office 1996). Many municipalities, lacking the ability to charge direct user fees, instead impose stormwater infrastructure requirements at the point of new or re-development, or gain voter approval for taxes. In the worst-case scenario, they pay compliance costs from general funds, a strained funding source for most cities since the Great Recession (Wetzel 2013). To our knowledge, no studies explicitly examine the efforts or funding options of nontraditional entities like universities to comply with Phase II permits.

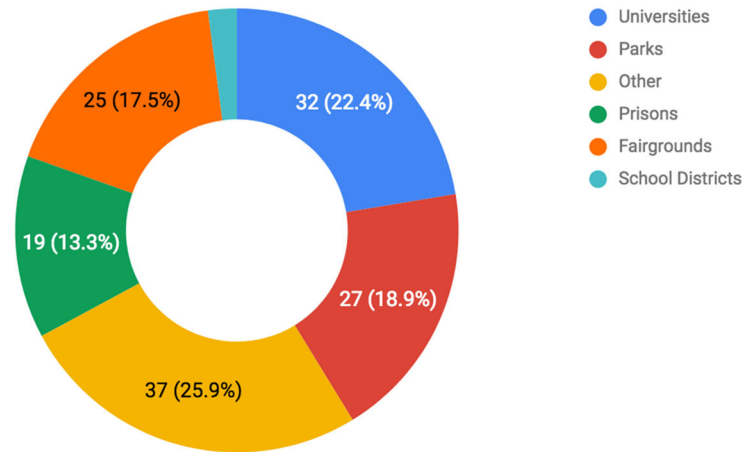
## Public University Campuses in the MS4 Regulatory Structure

Public<sup>1</sup> university campuses represent a large proportion of “nontraditional” Phase II MS4 permittees in California (see Fig. 1). Thirty-two of the 143 nontraditional permittees are university campuses; these campuses have a combined student, faculty and staff “population” of over 830,000 (calculated using data from the National Center for Education

<sup>1</sup> Private California universities are not subject to Phase II MS4 permits like public campuses and instead manage stormwater as any large private developer might. For example, the private University of Southern California (USC) does not have MS4 compliance requirements and follows the City of Los Angeles’ Low Impact Development guidelines like other developers (USC Sustainability Office, personal communication 2018). While free from regulatory requirements, USC still faces challenges to innovative environmental management. The campus delayed recycled water use until the city connected their purple pipe infrastructure and has found campus-wide stormwater capture to be economically infeasible (Lindberg 2019).

**Fig. 1** Nontraditional phase II MS4 permittee types in California

**California Phase II Permittees**



Statistics Integrated Postsecondary Education Data System 2016). The five UC campuses in our study together comprise a population of over 220,000<sup>2</sup>, over a quarter (26.5%) of the entire population of students, faculty, and staff covered by Phase II permits in California. Public university campuses have a relatively higher impact on stormwater runoff than other nontraditional Phase II MS4 permittees; average populations reported in campus Phase II permit applications (known as Notice of Intent applications or NOIs) are much higher than prisons and fairgrounds (see Table 1).

The size of large public university campus populations supports the ‘cities within cities’ analogy. Equally important, while most if not all of these universities are situated within city boundaries, their physical campuses are not legally required to comply with many local and state regulations. Public university campuses—as opposed to privately-run campuses—receive special land use and development power as constitutionally-created entities of the state (UC Irvine 2007; UC Berkeley 2004). University of California (UC) campuses are not required to adhere to city and county general plans, community plans, or zoning regulations and instead create their own Long Range Development Plans. The University of California is the only agency with local land use jurisdiction on campus projects (UC Irvine 2007). While campuses typically voluntarily cooperate with surrounding communities in planning, this autonomy can isolate campuses as the functional but not legal equivalent of “small cities” within legally-enshrined cities. This isolation serves along with their standalone significant environmental impacts from extensive development and concentrated populations, as the justification for having separate MS4 permitting (Alshuwai-khat and Abubakar 2008). This clear delineation and

**Table 1** Average population of public universities versus prisons and fairground nontraditional permittees

	Average population	Range of population
Public University Campuses ( <i>n</i> = 31)	22,050	[1124, 79,000]
Prisons ( <i>n</i> = 17)	4050	[1000, 10,000]
Fairgrounds ( <i>n</i> = 18)	1777	[0, 7135]

Population figures were obtained from NOI applications uploaded to the State Water Board SMARTS database—not all nontraditional permittees provided these application files

designation of stormwater runoff responsibility at the campus level also coheres with Principle 1 of global good water governance principles laid out by the Organisation for Economic Co-operation and Development (OECD 2015).

While difficulties exist in MS4 compliance, public university campuses may be motivated to comply in order to demonstrate leadership in sustainability, given that universities often have prominent, flagpole environmental campaigns and their residents support sustainable practices more than the general population (Nejati and Nejati 2013; Barth and Timm 2011; Marans and Shriberg 2012). The University of California has many strong environmental commitments, including a target of carbon neutrality by 2025 and 20% reductions in per capita potable water use by 2020 (University of California 2017). Widely publicized campus-specific goals, such as UCLA’s Zero Waste initiative, provide positive public relations benefits (UCLA 2012). However, whether universities can comply with minimum MS4 regulations (let alone take sustainable and visionary strides in the stormwater arena) remains an open question this study explores.

To answer this question, we first review existing literature on environmental regulatory compliance on university campuses. We then present methodological details and original results from research on stormwater management

<sup>2</sup> Population values provided by the five southernmost UC Campuses in their 2013 Phase II permit Notice of Intent (NOI) letters sum to 220,063.



practices and decision-making in response to MS4 regulation on five University of California campuses. The study concludes with implications for policy and further research.

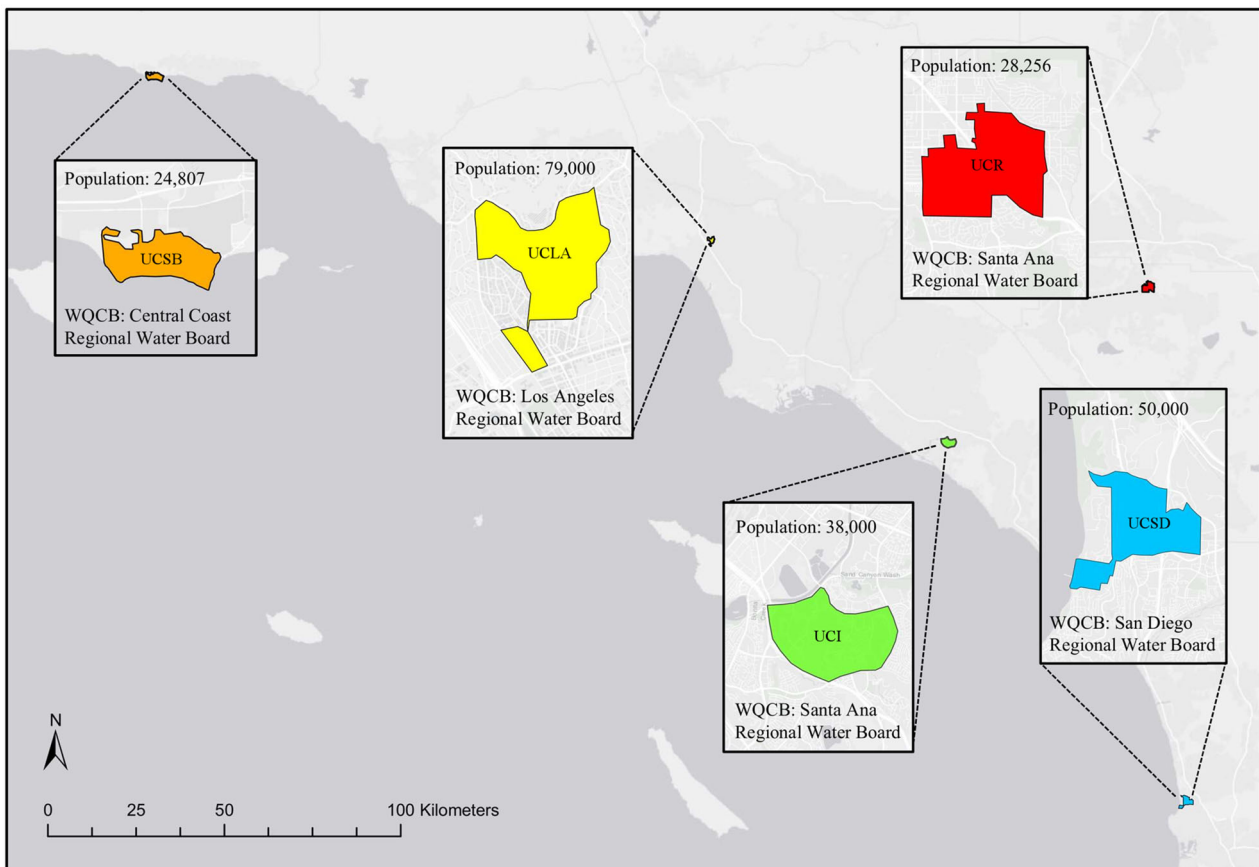
### Environmental Regulatory Compliance Regimes and University Campus Management

Existing literature generally finds that top-down environmental policy regimes do not adequately account for local variation. A “one-size-fits-all” federal environmental regulatory approach results in inflexible permit requirements that prevent local innovation (Adler 2004). Federal permit structures, including the MS4 process, integrate poorly with existing development processes and pre-existing regulatory requirements; the U.S. federal system creates institutional obstacles to environmental policy integration and coordination (Hanson 2019; Jordan and Lenschow 2010; Rabe 1995). As municipalities already experience inefficiency and costly permit delays, existing environmental regulation often hinders opportunities for new and innovative methods like green infrastructure projects (Ulibarri et al. 2017). Since campuses act as both planners and developers, they face similar constraints to

accessing funding and implementing new stormwater management techniques.

While studies frequently examine the pro-environmental preferences of campus residents (for instance see: Attaran and Celik 2015; Whalen et al. 2013; Emanuel and Adams 2011; Pike et al. 2003), studies on university campuses’ environmental compliance or sustainability performance are limited. Only one study, a master’s thesis (Garrett 2017), directly touches on campus stormwater management. Other work suggests that, while university campuses increasingly focus on sustainable management of their own facilities, they face numerous barriers that prevent successful implementation of sustainable strategies (Shiel and Smith 2017; Blanco-Portela et al. 2017). Complex administrative structures and siloed campus departments make it difficult to enact the cross-disciplinary and campus-wide initiatives required for effective programs (Shiel and Smith 2017). While many campuses have “green building” or “campus greening” initiatives to upgrade structures, these efforts are often piecemeal and not connected to system-wide change (Shiel and Smith 2017).

The organizational culture and traditional reward mechanisms of universities also tend to be disciplinary in



**Fig. 2** Boundaries and locations of the five southern UC campuses with campus populations<sup>3</sup> and Regional Water Quality Control Boards (WQCBs)

nature and do not encourage cross-campus initiatives. Many environmental committee members or staff must focus on smaller-scale, bounded projects which require less participation at the cost of reduced impact (Elliott and Wright 2013; Sharp 2002; Hoover and Harder 2015). Information access and disclosure by universities to their residents or the general public regarding sustainability performance or environmental compliance are not straightforward (Larrán Jorge et al. 2018). Accordingly, some argue a sustainable campus requires a multi-pronged, top down and bottom up approach—responding to student interest/investment and a combination of infrastructure, curriculum and policy changes (Pedersen et al. 2017; Parnell 2016). Finally, universities possess fewer and less flexible financing tools than cities, where problems with adequate revenue for environmental compliance are already well documented (Keeley 2007; Grigg 2012; Garrett 2017). Our study examining five public universities corroborates these findings from the literature on challenges to campus sustainability and innovation.

## Data and Methods

This study was conducted as part of a larger University of California (UC) Multicampus Research Initiative project entitled “Fighting Drought with Stormwater: From Research to Practice.” The overall project generated engaged research to transform five UC campuses (see Fig. 2) into living laboratories to demonstrate how stormwater infrastructure can safely augment existing water supplies and minimize flood risk and urban runoff pollution.

Multiple, sequential complementary research methods and data sources traced the process of decision-making for stormwater management on each campus (Kay and Baker 2015). We first conducted a comprehensive review of current and pending campus MS4 permits, Water Action Plans, infrastructure financing strategies and other written policies regarding office authorities and responsibilities for stormwater management. Next, based on this review, we conducted 23 semi-structured interviews with campus officials at each of the five southernmost UC campuses, the UC Sustainable Water Systems working group, regional board and State board officials, and consultants at environmental engineering firms which routinely work on MS4 compliance between May 2017 and January 2018. Finally, we deployed an online survey to students and staff at each of the five UC campuses from September 2019 to April 2020 that assessed willingness to pay for natural treatment systems on campus (an innovative green infrastructure technique to manage stormwater).

<sup>3</sup> Populations were stated by the campuses in their Notice of Intent (NOI) letters for Phase II permits in 2013.

Three of the named authors leading this study selected on-campus interviewees by first approaching each campus environmental health and safety office and sustainability office to ask for an interview with their primary decision maker on stormwater management, as well as asking the UC-wide working group for their top campus contacts. Subsequent on-campus interviewees and relevant engineering firms ( $n = 5$ ) to each campus were approached based on the snowball sampling method from initial on-campus interviews. At least two interviews were conducted with officials on each campus ( $n = 14$ ). Each regional board relevant to the campuses as well as the State Water Board and Department of Water Resources were interviewed ( $n = 4$ ).

A semi-structured interview guide was designed for a 45 min to 1 h conversation with interviewees regarding their knowledge of (1) nontraditional MS4 permit expectations, (2) the active roles of on-campus offices in compliance and stormwater management choices, (3) the extent of cooperation and conflict between offices in stormwater and landscape management, (4) current and prospective funding sources for stormwater management, and (5) their views on challenges to and opportunities for proactive stormwater management on campuses as compared to cities. To safeguard interviewee confidentiality and encourage candid responses, only organization names of interviewees are identified; the names, titles, or specific units of interviewees are not revealed when attributing their opinions in this study.<sup>4</sup> Two named authors of this study manually and separately conducted thematic coding of the top themes of the content of each interview using a list of ten codes determined before the interviews were conducted. Based on the combined assessment of each interview, we then identified the top four most prevalent themes for analysis across all interviews.

We complement these findings with the results of a short, voluntary survey<sup>5</sup> we conducted from September 2019 to April 2020 among students and staff at the five campuses. Respondents were recruited via randomized emails to students through campus registrar offices, emails sent by campus staff and student government associations<sup>6</sup>, and emails sent to students in introductory environmental courses<sup>7</sup>.

<sup>4</sup> Before finalizing the study, we shared a draft with each interviewee and invited comments and criticisms; only four interviewees responded and only two had substantive comments which we incorporated into revisions.

<sup>5</sup> Human subjects approval was granted for this study through UCLA (IRB # 16-000773-AM-00005) and UC Irvine (IRB # 2817-1).

<sup>6</sup> All five UC campuses have staff assemblies, undergraduate student governments (Associated Students), and graduate student assemblies.

<sup>7</sup> We relied on randomized emails to students via the registrar offices at three of the five campuses. The remaining two campuses prohibited campus-wide emails to students, which resulted in the other recruitment methods and much lower response rates. No email service is available for staff members, so survey invitations were sent through the campus staff assemblies only.



Respondents were asked a series of closed and open-ended questions regarding their support of stormwater and green infrastructure (in the form of natural treatment systems) on their campus. A total of 1157 responses were collected via an online survey administered by SurveyMonkey which yielded 868 complete, valid responses<sup>8</sup>. The final sample size included 434 undergraduate students, 224 graduate students and 210 staff members and was analyzed in IBM's Statistical Package for Social Sciences (SPSS) 25.

The central findings from the survey relate to support and willingness to pay (WTP) for natural treatment systems on campus, a type of green infrastructure that represents more innovative stormwater management techniques. Contingent valuation (CV) surveys are common in the literature to value stormwater infrastructure (for instance see Groothuis et al. 2017; Wang et al. 2017; Chui and Ngai 2016; Cadavid and Ando 2013; Lindsey 1990). Our literature review did not reveal any surveys that value stormwater infrastructure among campus populations but other CV studies of environmental goods use student populations (see Attarana and Celik 2015; Gossling et al. 2005). Similar to Chui and Ngai (2016) and Blaine et al. (2005), we use a payment card approach that provided value ranges for respondents to choose from, which Donaldson et al. (1997) infer provides more valid results than open-ended questions. For respondents indicating no willingness to pay, we included a follow-up question to ascertain reasons and determine instances of protest bids (Blaine and Litchkoppler 2016). The WTP question complements an additional survey question on support for campus spending on natural treatment systems to ascertain student and staff interest in stormwater management decisions and feasibility of financing options for campus stormwater infrastructure.

## Results

We find that actual stormwater management practices and land allocation to related infrastructure on public university campuses are constrained by four main factors: infrastructure financing constraints, a lack of coordination and collaboration in stormwater management and decision-making, a lack of transparency and campus resident involvement, and regulatory inflexibility. These factors make universities a poor fit for their MS4 permittee status alongside municipalities. These four factors are presented below, supported by findings from our mixed-methods approach: interviews and a study of student and staff

willingness to pay assess financing constraints; interviews and a review of campus MS4 permits assesses lack of coordination in management and decision-making; and interviews examine how regulatory inflexibility prevents campuses from using alternative compliance methods.

## Financing Constraints

Many cities struggle to fund projects and the ongoing maintenance necessary to comply with MS4 permitting and regulations (Keeley 2007; Grigg 2012). The MS4 program largely remains an unfunded mandate to cities. This also applies to campuses as Phase II permittees, which have even fewer funding tools at their disposal than cities. Table 2 summarizes the potential funding mechanisms for campuses, along with the potential magnitude and feasibility of those funds, based on findings from interviews and our review of campus infrastructure financing instruments.

Municipalities can assess taxes and fees on their residents to raise revenue for stormwater—a strategy numerous cities and counties already employ and which has seen more success at the ballot box in California since the most recent drought (NAFSMA 2006). By contrast, university campuses do not assess development taxes on builders and cannot assess taxes on their residents, except through limited fees on their student population. Instituting a new student fee at a UC Campus requires a majority vote of the student body during the yearly elections cycle (UCOP 2007). The Green Initiative Fund is one student fee that student votes approved at all five UC campuses in this study, ranging from \$1.67 per academic quarter at UC San Diego to \$4.80 at UCLA. The collected funds are disbursed to student-led campus sustainability projects during quarterly application cycles (Student Sustainability Collective 2018; UCLA Registrar's Office 2018).

Passage of even a small fee to finance MS4 compliance could be difficult; students already pay multiple long-standing fees, such as for athletics and transportation, and may be reticent to approve additional charges. However, our survey of students reveals general support for this financing method. Student respondents were asked "What additional amount (beyond the \$X you currently pay) would you be willing to pay<sup>9</sup> each quarter to support the construction of natural treatment systems on your campus?" Only 9.3% of students (58 of 623 responses) were not willing to pay any amount. The average willingness to pay

<sup>8</sup> The survey took an average of 15 min the final sample excluded respondents spending <5 min as this was found to identify surveys with significant blank responses. Responses were also deemed invalid without a campus affiliation (undergraduate, graduate student, or staff).

<sup>9</sup> Respondents were presented with 4 increments of \$20 each from < \$0 to \$100 followed by four additional \$5 increments within their initially selected \$20 increment. The median of the final \$5 increment was calculated as the willingness to pay of each respondent. Natural treatment systems were described in the survey as an innovative form of green infrastructure for stormwater management.

**Table 2** Potential campus funding opportunities

Mechanism	Potential magnitude	Feasibility
Student fees	Medium	Medium: must pass student referendum
Faculty/staff payroll deductions	Low	Medium: must create a fund to accept voluntary donations
Visitor fees (e.g., parking)	Medium	Low: most money already earmarked
Bonds	High	Low: usually bundled and require revenue stream
State loans (Stormwater Grant Program)	Medium	Low: requires matching funds
General funds	Low	High: already done, but competing priorities

(WTP) was \$26.02 (SD = \$24.83) per quarter and the median WTP was \$18.00—a yearly average WTP of \$104. The challenge of new fees, however, is illustrated by the 58 students who were not willing to pay and answered an additional question with the reasons why. The most common reason was that fees were too high already (69%).

While an established process exists to add student fees, there are currently no means to add recurring staff fees. Voluntary fees are leviable whereby staff and faculty can opt to have an automatic transfer from their paycheck sent to a campus initiative of their choice (Office of Development n.d.). However, this transfer must be allocated to an existing initiative or fund. According to our survey, staff are far less willing to personally fund stormwater on campuses than students. Of 169 staff respondents, 39% ( $N = 82$ ) were not willing to support natural treatment systems on campus via a monthly paycheck deduction. The average monthly WTP of staff was \$9.51 (SD = \$14.88) with a median of \$12.50 (\$114 average annual WTP). While this WTP is slightly higher than the average annual WTP of students, significantly more staff than students are not willing to pay at all (at 99.9% confidence level using a Pearson chi-square test). Of the 82 respondents not willing to pay, the majority did not feel comfortable committing to monthly paycheck deductions (73%) followed by feeling that donations were an inappropriate way to fund natural treatment systems (48.8%) and a desire to save money for other things (29%)<sup>10</sup>. Visitor fees, such as parking or additions to sales tax for on-campus purchases, might be additional substantial sources of revenue, but are currently allocated to maintain the service offered or to purposes controlled by more influential campus departments (UCI Transportation and Distribution Services n.d.).

As is true for cities, university campuses do have the option to assess bonds and, in theory, to tap into State funding opportunities to subsidize stormwater projects. The vast majority of University capital projects are funded by bonds, especially university-issued bonds, since the proportion of State funding for capital projects has steadily

declined over the last decade (Accountability Report 2017). Campuses are unlikely to secure bonds unless they can demonstrate a revenue stream. The UC Regents, the 26-member governing board of all 10 UC campuses, pledged general revenues, which include student tuition and fees, as security for the most recent \$1.2 billion in bonds issued in May 2018 (Moody's 2018). No bonds have yet been issued for the sole purpose of stormwater or environmental compliance, raising questions as to the feasibility of this approach, especially given the tendency for the Regents to bundle bonds and issue them in large billion-dollar sales.

Low-interest loans for MS4 permittees, provided by the California State Water Resources Control Board through Proposition 1 funding, are another possible means of funding stormwater projects. The competitive process made funds available for planning (\$20 million) and implementation (\$166 million with an additional \$25 million from other existing propositions) (State Water Resources Control Board 2015). Beyond the inherent difficulty of applying for State funds, UC campuses may not apply without a matching grant, which makes Proposition 1 funding difficult to secure in practice (State Water Resources Control Board, personal communication 2017), an obstacle which on-campus interviewees also noted.

In the absence of the above funding streams, campus 'general funds' are inevitably allocated to support stormwater management. Just as in cities, campus general funds must be split amongst many competing priorities; on average campuses report that they only support the minimum, or less, required for permit compliance. As the one campus in this study reporting exceedance of MS4 permit obligations, UC San Diego (UCSD) achieved success thanks to a large dedicated funding stream comprised mostly of independent grants (UCSD EHS, personal communication 2019), demonstrating the necessity of adequate funding as a precondition of success.

### Lack of Coordination and Collaboration in Stormwater Management and Decision-Making

As noted earlier, literature has found that organizational structure can hinder the potential for innovations in environmental management. Cross-department coordination that

<sup>10</sup> Respondents could select all reasons that applied, responses add up to more than 100%.

would improve stormwater management can be difficult due to campus administrative structures or organizational culture (Shiel and Smith 2017; Elliott and Wright 2013; Sharp 2002; Hoover and Harder 2015). Our analysis of campus stormwater management across the five southern UC campuses finds evidence of this lack of cross-campus coordination; despite efforts to emphasize collaboration in MS4 permits, much of the compliance burden falls on a single under-resourced campus office.

Each campus' MS4 permit lists a range of offices and departments as actors and stakeholders. Despite similarities in official stormwater management policy across these campuses, we found via our interviews that actual management practices can differ dramatically from what is outlined in permits. We found a substantial disconnect between offices listed in permits and those with high involvement levels in practice (see Table 3). According to interviews with officials at each campus, only the Environment, Health, and Safety Office at most campuses consistently exhibited high activity in stormwater management—defined as playing an active role in MS4 permit compliance (as opposed to permit renewal)—and/or green infrastructure construction and education on campus.

Each campus except for UCSD placed most of the functional burden for meeting regulatory requirements on the Environmental, Health & Safety (EHS) office. In this respect university campuses are much like cities, which often have multiple actors and stakeholders in stormwater management—all with diffuse responsibility—while the main compliance burden falls on specific offices within the Public Works Department (for instance, see City of Los Angeles 2018; Santa Monica Public Works 2018; City of Vernon 2018; City of Industry n.d.).

### Lack of Transparency and Campus Resident Involvement in Decision-Making

Despite campus residents being some of the greatest advocates of progressive resource management in society, as illustrated by student involvement and support of

initiatives such as the UCLA Grand Challenge and the UC's Carbon and Energy Neutrality goals, they do not report being involved in on-campus stormwater decisions. Further, the portion of our review focused on current campus decision-making procedures finds a general lack of transparency to students or opportunities to incorporate student feedback, despite the fact that many are residents of campus housing and analogous to citizens of municipalities. On-campus decision-maker interviewees also reported that campus surveys, which are conducted for MS4 participation requirement compliance, did not facilitate broader involvement by campus residents in management decisions.

Campuses have no city council meeting equivalent to encourage participation or require public disclosure in campus-level decisions. Public hearings and open meetings with public comment periods are central to city- and county-level government accountability and transparency (Adams 2004). State laws like California's Brown Act require opportunities for public comment and adequate public notice of upcoming hearings, meetings and agendas (Adams 2004). Open meeting provisions do not apply to the University of California outside of The Board of Regents, the main governing body of all 10 campuses (see Bagley-Keene Act) (UCOP 2010). While students can submit written comments or attend open Board of Regents meetings, these meetings occur for two days every other month at different UC campuses and focus on university-wide issues in addition to campus-specific issues such as approvals of Environmental Impact Reports for development projects (Board of Regents n.d.).

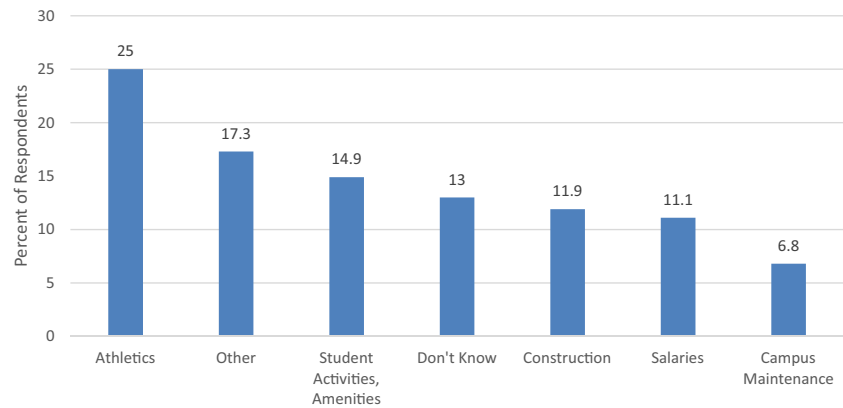
There has been open discussion regarding the disconnect between the Regents' university governance structure and the need for campus-level decision-making. In a 2012 paper, the former UC Berkeley Chancellor proposed a new governance structure in which the Regents would delegate responsibilities to newly created campus boards (Birgeneau et al. 2012). This approach could provide more effective oversight at each unique campus and more opportunities for student representation (Birgeneau et al. 2012). Campus residents would likely do more if provided with opportunities, and informed how, to participate in and influence decision-making on their campuses.

Moreover, many cities now have open data initiatives which provide easily accessible public data. A surge in municipal open data portals occurred after Chicago created one in 2010; just in Southern California, the cities of Los Angeles, Bakersfield, San Bernardino and Santa Monica all now have data portals (Brown 2017). University campuses have not, as yet, been as forthcoming as other public agencies with data and information on campus operations and policies. For instance, the GRI Sustainability Disclosure Database collates and publicly provides sustainability reports from a variety of organizations including

**Table 3** Stormwater compliance offices on five UC campuses

UC campus	Number of offices listed in permit	Number of offices involved in stormwater management	High activity offices
Santa Barbara	Nine	Five	Two
Los Angeles	Five	Three	One
Irvine	Two	Eight	Two
Riverside	Nine	Two	Two
San Diego	Nine	Five	Four

**Fig. 3** Reasons given for reallocating campus funds to natural treatment system investments ( $N = 664$ )



universities, private companies and public agencies (Global Reporting Initiative n.d.). As of July 2018, UC Berkeley and UC Santa Cruz were the only UC campuses who shared annual sustainability reports via the database (Global Reporting Initiative n.d.). Sustainability reporting by public sector organizations not only increases transparency to stakeholders but can drive organizational change (Domingues et al. 2017).

While campuses currently fail to sufficiently incorporate students into development decisions, the results of our five-campus survey, however, indicate campus residents do possess strong opinions about current campus development decisions and resource allocations, or a desire to learn more. Survey respondents were asked on a 7-point scale from “not supportive at all” to “very supportive”, “do you support the University of California allocating more money from its general funds to construct natural treatment systems for stormwater management on UC campuses?” An overwhelming majority (87%) of the 868 respondents were some degree of supportive (43% very supportive, 28% moderately supportive, 15% slightly supportive). Only 4% of respondents were some degree of unsupportive.

Respondents were also asked an open-ended question of what they would support their campus spending less money on in order to make funds available for natural treatment systems on campus. Among the 664 respondents, Fig. 3 shows that athletics was the most common response (25%) but a consistent number (13%) also answered that they would not know without learning about the campus budget (‘Don’t Know’). This suggests that students, if given opportunities to learn about campus development and funding decisions, would voice opinions and support reallocating funding for more innovative stormwater management.

Allowing students more voice in decision-making may help address the status quo that, on campuses as in cities, stormwater compliance is constrained by development-driven land use decision-making. Optimal compliance strategies and voluntary stormwater capture on campuses

are likely to be overridden by development decisions or go unpaid for by on-campus “developers” (capital projects and academic departments). For example, on one campus, a large underground tank was built for the purpose of stormwater management and reuse. A few years after construction, however, it was put out of commission when the athletics department and capital programs were given permission to build a new athletic field in the same location. While only a small sample of campuses was explored during this study, we note that the pressure placed on decision-making in favor of development interests appears to positively associate with the opportunity cost of land values; campuses with more limited and expensive real estate appear to favor less progressive policies.

### “Square Pegs in Round Roles”: Regulatory Inflexibility

California’s 2013 Phase II MS4 General Permit provides some flexibility in terms of compliance activities for non-traditional permittees, such as universities, particularly for outreach and education components. Still, university campuses appear to be, as one campus official told us, “square pegs in the round hole” of the MS4 compliance process; campuses are thus disadvantaged in their attempts to meet compliance requirements. Oversight of MS4 permittees in California is administered by nine Regional Water Quality Control Boards (RWQCBs) (State Water Resources Control Board 2018). However, much of the RWQCBs’ focus is on larger Phase I permittees. For instance, one senior Los Angeles Regional Board official interviewed was unaware that campuses had individual permits, stating that she “had assumed that public university campuses fell under city stormwater permits”. Certain opportunities for regulatory flexibility are not available to campuses to improve management. In particular, campuses are often informally excluded from the alternative compliance programs common for Phase I permittees such as the Enhanced Watershed Management

Programs (EWMPs) allowed by the Los Angeles Regional Board (Los Angeles Regional Water Quality Control Board 2018). Both campus officials and stormwater consultants confirmed that it is difficult, if not impossible, for universities to participate in alternative compliance processes, like EWMPs, preferred by other permittees. One consultant said that campus inclusion was “technically possible, but EWMP groups ultimately wouldn’t value campuses as a strategic partner given their size.” It would be difficult to include campuses in these plans, as their governance structures, permits and requirements differ from other permittees. Campuses would require adjustments in permitting designations monitoring and other aspects to facilitate alternative compliance and benefit from more flexible compliance options.

Due to the above-noted factors, the five UC campuses detailed here face stronger obstacles to progressive stormwater management than cities due to four challenges in MS4 compliance: constrained financing options, difficulties in cross-campus coordination, lack of transparency and stakeholder involvement to advocate for changes, and regulatory inflexibility. While this does not mean campuses are necessarily out of compliance with their permit, some campuses have received violations which required prompt corrective action, highlighting the difficulties. For example, the Santa Ana Regional Board audited UC Irvine in October 2017 and found violations of several sections of its MS4 permit (Beckwith 2018). While the issues were corrected and addressed by the mandated deadline, the violation demonstrates that at least one campus already struggles to implement the myriad elements of the MS4 permit, let alone enact innovative strategies (Gomez 2018), despite its progress in other areas of environmental performance like energy efficiency (O’Reilly 2018).

## Discussion

This study highlights the unique challenges university campuses face as compared to cities in MS4 permit compliance, which may hinder their ability to adopt innovative management techniques to align with the progressive environmental image which many project. This disconnect is particularly important because, with challenges of water shortage and drought across California, the campuses in our study may be missing opportunities for leadership in modeling innovative stormwater capture and reuse practices which can affect broader management practices. This disconnect applies more broadly to California, the U.S., and global urban contexts in which current aging water infrastructure and lack of financing serves as a barrier to the adoption of innovative approaches and multi-functional investments that could more holistically address water

pollution and water supply issues (Feingold et al. 2017; Essex et al. 2019; Sadoff et al. 2020).

On and off-campus interviewees repeatedly expressed that one of the inherent challenges in enforcement of MS4 Phase II permits on university campuses lies in the top-down, generalized approach common to MS4 implementation. This top-down approach tasks campuses with nearly the same responsibilities as municipalities despite their different governance and financing structures. Research by Morison and Brown (2010) suggests that a similar “cookie cutter” approach to stormwater management was unsuccessful in Australia because it failed to account for differences in resource, fiscal, and institutional capacity amongst local governments.

In another similarity with municipalities, our review and interviews suggest that the major campus decision-making units for stormwater permit compliance fall into stylized camps that mirror the tensions cities face between development and sustainability (Molotch 1976; MacLeod 2011). Whereas Campus Facilities and Sustainability offices tend to be proactive and engaged in supporting EHS to comply with or exceed permit targets, the Capital Projects, Housing, Labs and Hospitals and Groundskeeping departments tend to prioritize other interests, sometimes even taking actions that directly hinder stormwater management efforts. Multiple interviewees across campuses stated anonymously that the land use and building concerns of campus athletics and revenue-generating units would ultimately trump MS4 permit considerations if there was a conflict between priorities on their campus. As Peiser (1990) notes in the context of city planning, developers—influenced by consumer preferences, financial considerations and market trends—tend to determine what gets built on the ground. Developers’ objectives, however, often conflict with the long-range plans or goals of planners (Peiser 1990; Grant 2009).

Reflecting another source of tension, our staff and student survey illustrates a discrepancy between strong student and staff support for funding innovative stormwater management and actual campus level decision-making. University campuses are often thought to have, or themselves project, strong pro-environmental values and attitudes amongst students and campus officials alike, including for stormwater and water conservation (Miura 2019; UCI News 2017; Carlson et al. 2017; Mok 2011; White 2011). However, this study suggests a gap between the progressive environmental rhetoric on university campuses and the cumbersome MS4 compliance process. Essentially, stormwater management on university campuses presents an example of the value-action gap (Gifford and Sussman 2012). Many of the external factors cited by environmental psychologists as barriers to pro-environmental behavior are apparent in the MS4 compliance process for universities



(e.g., governance structures not well suited to innovative approaches, inadequate financial resources and institutional capacity to take action, and competing priorities for time, money and attention) (Blake 1999; Leiserowitz et al. 2006).

The progressive action of university campuses in other environmental sectors, however, suggests that the status quo in campus stormwater management is surmountable. Existing partnerships by the University of California on energy efficiency provide an example of potential collaborative funding measures that could be used for stormwater infrastructure upgrades. In 2004, the University of California created a statewide Energy Efficiency Partnership program with the California State University system and the State's four investor-owned utilities to improve efficiency in higher education facilities (Accountability Report 2017). From 2004 through 2016, funded projects saved the University over \$194 million (Accountability Report 2017). Stormwater infrastructure upgrades on campuses provide another opportunity to conserve water and save the university money. Creating a UC-wide water program like the Energy Efficiency Partnership could provide the necessary capital for upgrades across campuses while providing multiple benefits and public relations opportunities for the UC system as a whole.

Despite the challenges, our interviews and review of practices at UC San Diego demonstrates that campuses can exceed MS4 compliance requirements by addressing the above obstacles through the coordinated efforts of multiple offices and central campus leadership. UCSD has been able to exceed MS4 permit requirements for stormwater management thanks to a large program funded with external grants and the creation of an Enterprise Utility with ongoing dedicated funding. As of January 2019, UCSD leveraged \$5 million in State grants to install five large stormwater improvement projects on campus (UCSD EHS 2019). Additionally, UCSD's stormwater program emphasizes a collaborative approach, working closely with Facilities Managers and onsite Operations and Maintenance staff responsible for BMPs while incorporating existing efforts into student curriculum as experiential learning opportunities (UCSD Urban Planning Program, personal communication 2019). UCSD's experience demonstrates that exceeding compliance is possible, largely by ensuring adequate funding streams and facilitating collaboration across campus and through the hierarchical administrative organizational structure.

In terms of transparency, as highlighted by several interviewees, a sister campus to the five UC campuses, UC Davis, provides an extraordinary amount of public water and energy data (with explanations) that could serve to guide the southern UC campuses towards greater transparency. UC Davis holds an educational event and four small outreach events annually to inform campus staff about stormwater compliance. During the events, campus staff collect about

200 surveys of campus residents' knowledge and preferences (reference redacted 2017). The five southernmost UC campuses could improve their public disclosure and education efforts by replicating UC Davis' efforts, which may prevent incurring a MS4 permit violation similar to UC Irvine's (which partly resulted from inadequate outreach).

Finally, all interviewees expressed that more tailored efforts need to be made by federal, state and regional regulators to enable campuses to raise funds for and comply with both the letter and spirit of MS4 permits. Leaders and regulators can address challenges with a vision for more collaborative regulatory actions, including the creation of new alternative compliance options (either specifically for campuses or to facilitate their inclusion in existing watershed scale compliance efforts). Fragmented jurisdictions already challenge stormwater management, an issue exacerbated by the exclusion of campuses from existing cooperative processes (Dhakai and Chevalier 2017). Additionally, the rules that essentially bar campuses from applying for public funding assistance to build green infrastructure must be rolled back.

## Conclusion

This study examines stormwater management by university campuses in the context of five University of California campuses. Research findings using multiple methods suggest public university campuses, despite their progressive image, are constrained in their ability to achieve effective stormwater management through the existing MS4 Phase II permit structure. In drought-stricken southern California, where stormwater could be managed as a water resource instead of a waste stream, campuses may be losing an opportunity to model and innovate around safeguarding water for the future. However, campuses' scope is limited by decentralized decision-making procedures within administrative offices, infrastructure financing constraints and lack of accountability to campus residents.

Our study suggests new insights for understanding the barriers facing campuses in environmental compliance and opens up a broader discussion about the potential impacts of different governance regimes on flexible environmental management and the discontinuities between environmental preferences and practice in non-participatory contexts. Several limitations exist in our research, most notably our small sample size of campuses and interview subjects prevents conclusions about other universities. Additionally, our survey had difficulty recruiting a sufficiently randomized population sample at two campuses due to restrictions in communication methods based on university policies. Larger random samples across more campuses could provide stronger insight into student and staff stormwater support to ascertain the potential

for fee-supported campus stormwater funding. Finally, concerns about the conclusions from contingent valuation methods are well-documented in the literature and must be critically evaluated (Blaine and Lichtkoppler 2016; Hudson and Ritchie 2001; Carson et al. 2000; Donaldson et al. 1997). Our own payment card approach framed the WTP question differently for students than staff, given the differences in quarterly student fees versus monthly voluntary staff donations, which could have affected respondents' WTP answers. Opportunities exist for further research, both to expand and improve upon our methods and findings and to explore other related avenues of research. In particular, further study of the value-action gap evidenced in progressive public institutions could prove useful to encouraging more innovative environmental management at such institutions. Parallel studies could also be conducted in other countries given the global challenges of urban stormwater management and the similarly decentralized stormwater regulation seen in other countries. Worldwide efforts to address the U.N. Sustainable Development Goal 6 for clean water and sanitation has increased focus on implementing and financing nature-based solutions to stormwater management (Sadoff et al. 2020), which makes efforts to adopt innovative stormwater management in U.S. public institutions like universities relevant more broadly.

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## Compliance with Ethical Standards

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