Perspective Piece

Diversity and Discrepancies in Water-related University Rankings: Is There a Need for More Consistency or Is There Value in Breadth?

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Access to clean water is an urgent and socially relevant global issue, as recognized by the U.S. National Academy of Engineers and most other global scientific agencies. Universities directly inform advances in this domain, serve as a training ground for practitioners who address challenges in water supply and quality, and more broadly educate scientifically literate citizens. However, it is challenging for students seeking information on university degree programs such as Hydrology or other water-focused areas to find consistent information about programs, in part because of the disciplinary diversity of this subject. Ranking systems typically focus on more traditional departmental groupings (i.e., geosciences, civil & environmental engineering, public health, etc.). While special rankings do occur for water science and engineering related programs, they are topically incorporated within various categories, including "Hydrology and water resources", "Water resources engineering", "Water treatment and sanitation", "Environmental and health sciences", and others that span traditional departments and have multiple homes within and across institutions. These may involve categories that are absent at a particular university that has strengths in the co-listed category. For instance, our home institution of Colorado School of Mines (or "Mines") offers well regarded degrees

and/or research programs in Environmental Engineering, Civil Engineering, Geophysics, Geology, and Hydrology, but lacks Public Health or Health Sciences degrees. Ultimately, water-focused domains of study fall outside of traditional degrees, groupings, and associated metrics leading to challenges in assessing strengths across both disciplines and degree programs.

Several ranking systems exist that rate universities based on their strength in a specific discipline, including water resources, but the metrics for each are quite different. Ranking systems are based on multiple factors including prestige of faculty members and publications, research funding, number and impact of publications, search engine traffic, international visibility, graduates in positions of influence, patent generation, perception by peer institutions, and financial sustainability, among others. The *QS World University Rankings* (QS), for example, is a ranking of the world's top universities (not degree programs) produced by Quacquarelli Symonds, that synthesizes peer rankings from thousands of scholars, academics, and recruiters in conjunction with Scopus citations, faculty/student ratios, and staff and student numbers. The *Times Higher Education World University Rankings* (THEWU), on the other hand, assesses universities using five categories: teaching, research, citations (research

influence), salary of graduates, and international reputation based on surveys. Another influential ranking system is the *Academic Ranking of World Universities* (ARWU), also known as "*Shanghai Ranking*", which is based on quality of education, faculty, and research output, among others. Beginning in 1983, *U.S. News & World Report* publishes an annual set of rankings of American colleges and universities that are based upon data from surveys that the organization collects from each institution, as well as opinions from faculty members and staff from other schools. This was expanded in 2014 to include *Best Global Universities*. As a synthesis approach, the *Aggregate Ranking of Top Universities* sums the QS, THEWU, and ARWU world ranks, excluding institutions that do not have a distinct rank in those three systems. Some educational institutions (e.g., *United Nations University* (UNU)) also publish their own ranking. Other international ranking systems include the *Center for World University Rankings*, the *Leiden Ranking*, the *G-factor*, the *Global University Ranking*, the *Nature Index*, the *Professional Ranking of World Universities*, the *Reuters World's Top 100 Innovative Universities*, the *Round University Ranking*, the *SCImago Institutions Rankings*, the *University Ranking by Academic Performance*, the *Webometrics Ranking of World Universities*, and the *Research Center for Chinese Science Evaluation Ranking at Wuhan University*.

With an increased visibility toward global issues on water availability and quality, there is growing interest in undergraduate and graduate degrees in water-related areas. In this sense, though the QS and many other ranking systems do not consider "water" as a searchable topic of interest, both THEWU and ARWU develop a global ranking system for some water topics. In contrast, the prominent *U.S. News and World Report Graduate Program Rankings* no longer includes specialties of hydrology or water resources science and engineering. Table 1 shows some water-related global university rankings for 2020, wherein one can see differences across similar ranking categories. Higher ranking universities such as The University of Arizona and Texas A&M appear under the Shanghai and UNU rankings, but are not even listed within THEWU. In contrast, UNC Chapel Hill appears under the

THEWU ranking system, but is not mentioned by the other two. Similar situations are shown for other educational institutions such as Wuhan University and the University of Colorado at Boulder. While different evaluation metrics can explain some of this, it also highlights discrepancies in binning water related programs across "Water resources" versus "Clean water and sanitation", which in this example necessitates very different foundational approaches and expertise.

National ranking systems also exist in the U.S. such as the *Forbes College Rankings* (which is based on student satisfaction, post-graduate success, student debt, graduation rate, and academic success). Other national ranking systems are based on factors such as faculty publications, annual fundraising, graduation rates, student's future earnings, affordability, internet appearance, and even athletics, nightlife, and campus quality. Examples include the *Council for Aid to Education*, the *Daily Beast's College Rankings,* the *Economist's Best Colleges,* the *Objective College Ranking*, the *Money's Best Colleges*, the *Princeton Review Dream Colleges*, the *United States National Research Council,* the *Faculty Scholarly Productivity Index*, the *Top American Research Universities*, the *Washington Monthly College Ranking*, the *TrendTopper MediaBuzz College Guide*, the *American Council of Trustees and Alumni,* and the *Niche College Rankings*, among others. Additionally, websites such as *universities.com* (which considers average tuition cost, student-teacher ratio, and number of enrolled students), or *stateuniversities.com* (which is only based on the number of enrolled students) provide each year a ranking of educational institutions available nationwide to learn about different professional fields. A ranking of the top-10 U.S. universities from these two websites is included in Table 2, considering different water-related topics; discrepancies among sites and categories are clear.

As one can see, another source of confusion is the diverse factors that go into ranking such as cost of tuition, student-teacher ratio, or popularity metrics. However, these factors do not address the quality of the technical, discipline-specific education that is better suited for overall university or college rankings. As an example, the University of Illinois Urbana-Champaign is ranked as one of

the world's best universities in water education (see Table 1), but it does not even appear in the U.S. top-10 list from Table 2. Similarly, University of Pennsylvania is listed #1 at universities.com under the "Hydrology and water resources" search, and #7 on stateuniversities.com, but the institution is not included in the international ranking systems (see Table 1). Another good example is Mines, which regularly appears in worldwide and U.S. lists (see Tables 1 and 2). Based on research accomplishments (i.e., grants and peer-reviewed publications), Mines is strong in hydrology and water resources engineering, but while it currently plays a leading role in treatment technologies, it is not included within the top 50 in the THEWU "Clean water and sanitation" international list despite being listed at positions 40 (not shown) and 22 in the Shanghai and UNU lists, respectively (see Table 1).

The above analysis shows a few of the discrepancies across U.S. and international ranking systems which can partially be explained by a blurring across traditional categories and evaluation metrics. While discipline-specific ranking systems have inherent flaws, there is growing interest in hydrology, water resources, water and wastewater treatment, and other water-related programs in association with increasing environmental concerns and a rising need for professionals in this important area. To this end, a rating system and clearer definition of the discipline should be carefully considered and implemented for both undergraduate and graduate programs. Students seeking water-related careers should have more options than to look at rankings based on "civil and environmental engineering", "public health" or "geosciences". Rather, we propose the creation of a more specific, transparent, "Water" ranking system that could better encompass the inherent diversity across this topic. This could be extended to associated sub-disciplines such as "hydrology", "treatment", "watershed management", "water resources", "water policy", and others. Similarly, a new "Water" ranking system should consider student-centric outcomes such as job placement and salary five years after graduating, among the other key factors previously listed such as research productivity and teaching. While analysis across different ranking domains can be used to inform prospective students, it is unnecessarily confusing and confined by traditional groupings and in some cases less relevant evaluation metrics. Rather our call to the academic community is to think about (and work on) key metrics needed to create a consistent and accurate ranking system for universities and programs that focus their efforts on water sciences and engineering. This evaluation needs to embrace the diversity and richness within this theme so as to best inform future students and practitioners.

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Table 1. Top 25 water-related universities globally across three different ranking systems for 2020.

Ranking	Shanghai Ranking ("Water resources")	United Nations University (UNU) ("Water resources")	Times Higher Education World University Rankings (THEWU) ("Clean water and sanitation")
1	Swiss Federal Institute of Technology Zurich (ETH)	University of Arizona	University of North Carolina at Chapel Hill
2	University of Arizona	Swiss Federal Institute of Technology Zurich (ETH)	Tongji University
3	Beijing Normal University	Delft University of Technology	Western Sydney University
4	Texas A&M University	University of California, Berkeley	Indian Institute of Technology Kharagpur
5	The University of New South Wales	The University of New South Wales	York University
6	Hohai University	Texas A&M University	Aix-Marseille University
7	Tsinghua University	Beijing Normal University	Anna University
8	Wuhan University	University of California, Davis	University of Auckland
9	University of Illinois at Urbana-Champaign	University of Bristol	Middle East Technical University
10	University of Bristol	Hohai University	University of Strathclyde
11	Delft University of Technology	University of Illinois at Urbana-Champaign	Tunghai University
12	University of Colorado at Boulder	Flinders University	RMIT University
13	Flinders University	Tsinghua University	Charles Turt University
14	University of California, Davis	University of Colorado at Boulder	King Mongkut's University of Technology
15	University of California, Irvine	University of California, Irvine	Metropolitan Autonomus University
16	University of California, Berkeley	The University of Texas, Austin	University of Wollongong
17	The University of Texas, Austin	University of Wageningen	Penn State University
18	The University of Queensland	University of Saskatchewan	Hindustan Institute of Technology and Science
19	Wageningen University & Research	Swiss Federal Institute of Technology Lausanne	University of Indonesia
20	University of Saskatchewan	The University of Queensland	Hiroshima University
21	Northwest A&F University	Wuhan University	University of Jaén
22	Princeton University	Colorado School of Mines	Kyung Hee University
23	University of Padua	Stanford University	An-Najah National University
24	Utrecht University	Oregon State University	University of Girona
25	Swiss Federal Institute of Technology Lausanne	University of Padua	Queensland University of Technology

Table 2. Best U.S. universities in 2020, from *universities.com* and *stateuniversity.com*, considering the two available water topics ("Hydrology and water resources" and "Water resources engineering").

Ranking	--------------- universities.com ---------------		--------------- stateuniversity.com ---------------	
	"Hydrology and water resources"	**"Water resources engineering"**	**"Hydrology and water resources science"**	**"Water resources engineering"**
1	University of Pennsylvania	University of Southern California	Texas A&M University, College Station	University of Nevada, Reno
2	University of California, Davis	Villanova University	Colorado School of Mines	University of Minnesota, Twin Cities
3	Rennsealer Polytechnic Institute	University of Minnesota, Twin Cities	University of Arizona	University of New Mexico, Main Campus
4	Boston University	Illinois Institute of Technology	University of Rhode Island	University of Southern California
5	University of Texas, Austin	University of Idaho	University of California, Santa Barbara	Oregon State University
6	Colorado School of Mines	University of Delaware	University of California, Davis	Villanova University
7	University of California, Santa Barbara	University of Nevada, Reno	University of Pennsylvania	University of Buffalo
8	Texas A&M University, College Station	Oregon State University	Vermilion Community College	Michigan Technological University
9	Brigham Young University, Provo	Michigan Technological University	New Mexico Institute of Mining and Technology	Central State University
10	University of New Hampshire, Main Campus	University of New Mexico, Main Campus	Boise State University	Gateway Technical College