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Soil Dynamics and Earthquake Engineering 25 (2005) 413–420

SOIL DYNAMICS AND EARTHQUAKE ENGINEERING

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On publication rates in earthquake engineering

M.D. Trifunac*

Department of Civil Environmental Engineering, University of Southern California, KAP 216D Vermont Avenue, Los Angeles, CA 90089-2531, USA

Accepted 15 April 2005

Abstract

It is shown that publication rates of earthquake engineering professors are essentially the same as the average publication rates of a sample of 443 science (59%) and engineering (41%) professors in the United States. This work was motivated by an observation that, in 2004, of 212 of the 'world's most cited and influential researchers' in the category of *engineering*, HighlyCited.com included no earthquake engineering faculty. Our results suggest that this outcome is not caused by the publication rates in earthquake engineering.

Keywords: Publication rates; Earthquake engineering

1. Introduction

Recently, HighlyCited.com (Thomson/ISI) started to collect data on the 'world's most cited and influential researchers'. In May 2004, HighlyCited.com had 212 members in the category of *engineering* worldwide. Of those, 152 work in the United States and, are distributed among 49 universities (79%) and 19 government laboratories or private corporations (21%). However, none of those 212 selected belong to the field of earthquake engineering. There could exist many possible reasons for this. For example, (1) earthquake engineering professors could be publishing less than the faculty in other branches of engineering, (2) the fraction of the published earthquake engineering literature that is included in the Institute for Scientific Information (ISI) database could be small, (3) citation rates in earthquake engineering could be lower than in other fields of engineering, (4) the time window used by HighlyCited.com (1981–1999) may be too restrictive, and so on. Those and other possible causes need to be studied before one can begin to explain the above outcome. In this paper, I examine only the first possible reason and show that the average publication rates in earthquake engineering are very close to the national average trends in Engineering and the sciences. Thus, other aspects of published works in earthquake engineering will have to be analyzed to explain the absence of earthquake engineers in the highly cited list of 'influential researchers'.

A consensus on what constitute adequate and meaningful measures of academic productivity does not exist at present. Therefore, in this work I will adopt a simplified approach and will attempt to quantify only the available direct data on publication rates in earthquake engineering. The difficulty of identifying all of the relevant factors that govern this data, and their causal relationships, will be addressed in future papers.

Even while focusing on only one component of productivity—published work—one is faced with a lack of criteria on how to weigh the quality of publications (does an article in a journal with a high Journal Impact Factor (JIF) receive the same credit as an article in a journal with a low or non existing JIF? see [1]), on how to categorize books and chapters in books, relative to journal papers, and on how to distribute the credit among multiple authors. Productivity can be measured by the average publication rate (total number of publications divided by number of years since the first publication), or by per-author publication rate. In this work, I will view those as *input* productivity—i.e. representing the input into the pool of scientific and engineering literature. In future papers, using the data on citations, we will consider only those inputs that have been cited, which will be called *output*, a measure of *recognized* productivity.

* Tel.: +1 213 740 0570; fax: +1 213 744 1426.
E-mail address: trifunac@usc.edu.

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doi:10.1016/j.soildyn.2005.04.008

The facts that an article is published and that it may be cited do not necessarily mean that the work is of high quality, is relevant, or contributes to the overall knowledge and understanding in the field of earthquake engineering. Published papers can only be viewed as statistical data points that contribute to an author's cumulative sums of such points. When the sums become large enough, we can consider accepting them as measures of recognized productivity, or simply as output.

Wanner et al. [2] argued that the important research results in the sciences are reported in refereed journals and that other journal articles, books, and other publications are less used by researchers to advance the science. Thus, weighing the publications becomes an important bibliometric issue, which is possible only within the study of a particular discipline [3].

Another important issue is how to distribute credit among the authors of a paper. Cole and Cole [4] proposed the use of 'straight count', which allocates all credit only to the first author. This method assumes that the order of authors listed on the paper reflects the level of their contributions. The problem with this count is that it discriminates against those researchers whose name appears late in the alphabetic listing [5].

The second method is 'adjusted count' (or 'fractional count', or 'per-author count'), which gives each author credit equal to $1/a_i$, where a_i is the number of authors. The advantage of the adjusted count is that it eliminates the bias of over-estimating production when the value of a co-authored paper is distributed among all contributors [6].

The third method, which will be used in this work, is the 'normal count'. It gives full credit to all contributors regardless of the order of the listed authors. The problem with this count is that it is not reasonable to expect that all co-authors contributed equally, especially when some publications list authors for social reasons, [7], or in the circles where the practice of making colleagues 'honorary co-authors' is common [8].

2. Data

2.1. Bibliometric data

Bibliometric indicators employed in this work to evaluate the published knowledge production will be derived from the Earthquake Engineering Abstracts (EEA) database, which is focused on the subject area of earthquake engineering and the related fields—structural and geotechnical engineering, applied mechanics, engineering seismology, and engineering geology. The EEA database was developed by the National Science Foundation (NSF)—supported National Information Service for Earthquake Engineering (NISEE), which during the past 30 years has been the leading repository for all relevant published work in earthquake engineering and the related fields (http://nisee.berkeley.edu/eea.html).

At present, the EEA database has more than 100,000 abstracts and can serve as a quantitative measure of who the active contributors in this field are. The EEA database was accessible free of charge until January 2004, when it became part of Cambridge Scientific Abstracts (CSA)—a privately owned information company located in Bethesda, Maryland, that publishes abstracts and indices for scientific and technical research literature (http://www.csa.com).

To quantify publication productivity in earthquake engineering, I will assume that the number of publications for each author can be approximated by the number of his or her contributions recorded in the EEA database of NISEE. This database includes most of the significant journal papers, reports, conference papers, and workshop contributions. To demonstrate that this is a reasonable approximation, I analyzed the data for 10 professors using their curricula vitae. Table 1 shows the total number of their published journal papers (y_1), reports (y_2), and conference papers (y_3), and shows the total number of their abstracts in the NISEE database (x), up to and including December

Table 1
Distributions among publication categories (computed from curricula vitae) and the number of abstracts in the NISEE database for 10 faculty in earthquake engineering

Faculty	Published journal papers y_1	Published reports y_2	y_1+y_2	Published conference papers y_3	Total $y_1+y_2+y_3$	NISEE Total[a] x
1	54	17	71	61	132	48
2	9	7	16	89	105	7
3	72	52	124	45	169	84
4	23	4	27	74	101	46
5	99	23	122	162	284	110
6	45	9	54	111	165	7
7	69	24	93	23	116	92
8	209	94	303	44	347	301
9	36	17	53	19	72	48
10	26	37	63	76	139	20

[a] As of December (2003).

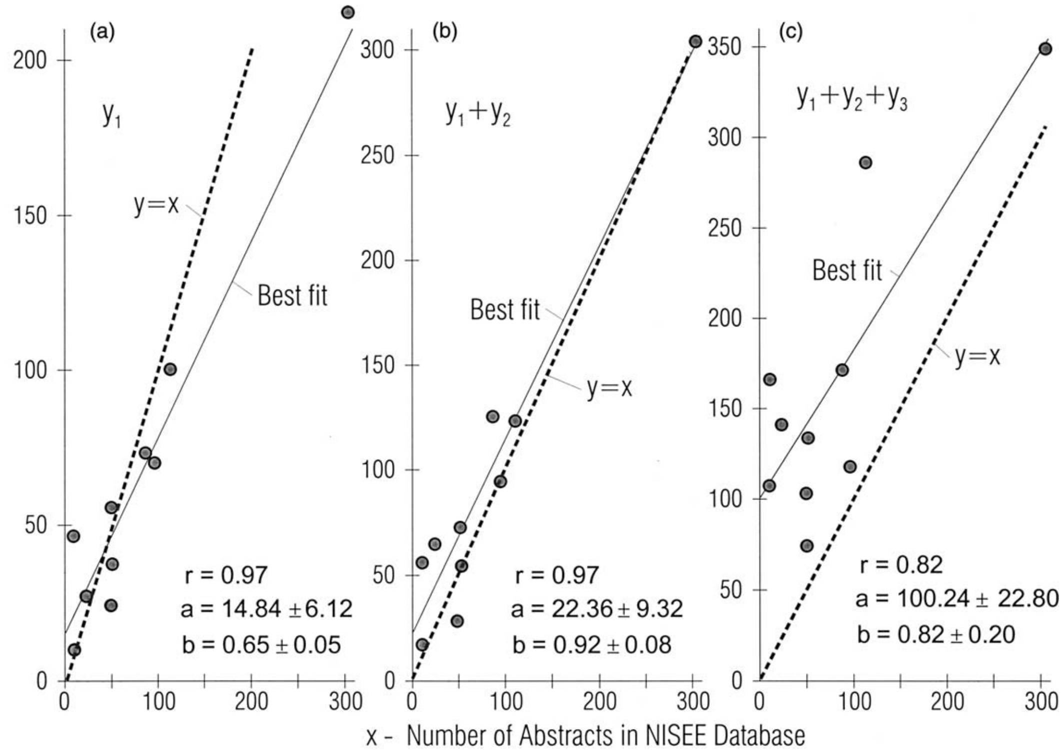


Fig. 1. (a) Number of published journal papers, y_1; (b) number of published journal papers and reports, y_1+y_2; and (c) number of published journal papers, reports, and conference papers, $y_1+y_2+y_3$. All are plotted versus the number of abstracts in the NISEE database, as of December (2003). Listed in each plot are the corresponding correlation coefficient, r, and the coefficients a and b in the straight-line fit of form $y=a+bx$.

(2003). Fig. 1a–c show y_1 versus x, y_1+y_2 versus x, and $y_1+y_2+y_3$ versus x, respectively.

Table 2 shows the best estimates for the coefficients a and b for the regression lines $y=a+bx\pm$SDs, and the correlation coefficients, r. It can be seen that the NISEE database (x) can be used to predict both y_1 and y_1+y_2 well.

For $x\leq 100$, Fig. 1a shows that y can be approximated by x (dashed line). The plot of y_1+y_2 versus x in Fig. 1b shows that y_1+y_2 is somewhat larger but that it also can be approximated by x. The correlation coefficients for data in Fig. 1a and b are high (0.97). When conference papers (y_3) are included in the total number of publications ($y_1+y_2+y_3$), correlation with x is still possible, but the scatter is large and $y_1+y_2+y_3$ is not $\sim x$.

2.2. Sample of 57 faculty

The sample of 57 faculty considered in this work was taken from a related study by Trifunac and Lee [3]. This sample is neither comprehensive (aiming to cover all areas of earthquake engineering) nor balanced (e.g. geographically, by seniority or by gender, etc.). It includes many past and present leading professors in earthquake engineering. From among the 57 faculty, 3 (5%) are deceased, 14 (24%) are retired, 37 (65%) are full professors, 1 (2%) is an associate professor, 1 (2%) is an assistant professor, and 1 (2%) is a research professor. This is equivalent to 40 (71%) 'active' faculty and 17 (29%) retired or deceased faculty. Overall, 54 (94%) of this sample are 'senior' professors, mostly working in civil engineering departments in the United States. Of, 57, 56 are male and 1 is female.

Considering the institutions where the 57 faculty graduated with doctoral degrees, the distribution is as follows: Caltech-11; U.C. Berkeley and Massachusetts Inst. of Tech-8; Stanford-6; Univ. of Illinois at Urbana-5; Columbia Univ.-3; Univ. of Southern California and State Univ. of New York at Buffalo-2; Illinois Inst. of Tech., Univ. of Canterbury, U.C. Los Angeles, Univ. of London, Univ. of Sidney, Univ. of Michigan, Rensselaer Poly. Inst., Rice Univ., Imperial College in London, Univ. of Ljubljana, Technion, and Kyushu University-1.

3. Publication rates

To maintain confidentiality, the faculty names have been replaced by an abbreviated code representing the institutions where they work, followed by a randomly chosen

Table 2
Coefficients in the straight-line regressions $y=a+bx$ for y_1, y_2, y_3, and x in Table 1

Function	a	b	r
$y=y_1$	14.84 ± 6.12	0.65 ± 0.05	0.97
$y=y_1+y_2$	22.36 ± 9.32	0.92 ± 0.08	0.97
$y=y_1+y_2+y_3$	100.24 ± 22.80	0.82 ± 0.20	0.82

Table 3
Institution codes and the number of faculty at those institutions considered in this study

American Institutions	CODE	Number of faculty considered in this study
University of California-Berkeley	UCB	UCB-1–UCB-12
University of Southern California	USC	USC-1–USC-8
California Institute of Technology	CIT	CIT-1–CIT-5
University of California-San Diego	UCSD	UCSD-1–UCSD-4
Stanford University	SU	SU-1–SU-3
University of California-Irvine	UCI	UCI-1–UCI-3
University of Texas	UT	UT-1–UT-2
University of Washington	UW	UW-1–UW-2
University of California-Los Angeles	UCLA	UCLA-1–UCLA-2
Columbia University	CU	CU-1–CU-2
State University of New York-Buffalo	SUNYB	SUNYB-1–SUNYB-2
Rice University	RU	RU-1–RU-2
University of Illinois, Urbana	UIU	UIU-1–UIU-2
University California Davis	UCD	UCD-1
Johns Hopkins University	JH	JH-1
Massachusetts Institute of Technology	MIT	MIT-1
Rensselaer P. Institute	RPI	RPI-1
Carnegie-Mellon	CM	CM-1
European Institutions		
Imperial College; London, England	IC	IC-1
Tech. University of Athens, Greece	TUA	TUA-1
University of Ljubljana, Slovenia	ULJ	ULJ-1

A total of 57 (56 male and 1 female) faculty are considered.

number. Table 3 lists the adopted abbreviations and, for each institution, presents the number of faculty included in this study. Fig. 2a–d present, for each faculty member the cumulative number of abstracts in the NISEE database, versus time, measured since the publication of the first abstracts (approximately equal to years since PhD). Fig. 2a–c present the cumulative input, respectively, of 18, 15, and 13 (total of 46) earthquake engineers, mainly in the US, and Fig. 2d presents the same for 11 ‘younger’ earthquake engineers.

By dividing the last ordinate in Fig. 2a–d by the corresponding x coordinates (years since the first abstract was recorded in the NISEE database) we can estimate the average publication rates. In Fig. 2a, for example, the highest publication rate is $302/37.5=8.05$ (USC-7), and the lowest is $99/50=1.98$ (CIT-1). Fig. 3 (bottom) shows the histogram of the computed publication rates for all 57 faculty included in the study. It can be seen that for this group the lowest publication rate is 0.87 and the highest is 8.05. The average for the group is $\bar{x}_t=3.34$ abstracts per year. Fig. 3 (top) shows the corresponding distribution function. It reveals that only two of the 57 faculty (3.5%) contribute more than seven abstracts per year, 5 (9%) contribute more than six abstracts per year, 10 (18%) contribute more than five abstracts per year, and so on.

Our sample of 57 faculty in earthquake engineering (Table 3) includes 3 (5%) deceased members, 14 (24%) retired professors, and 37 (65%) full professors, or 54 (94%) senior faculty (Fig. 4a). Thus, the above average publication

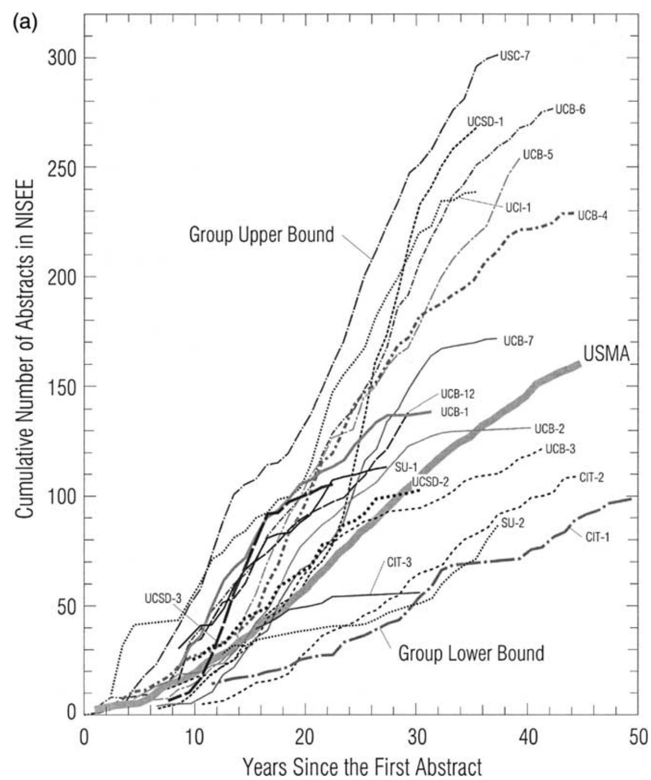
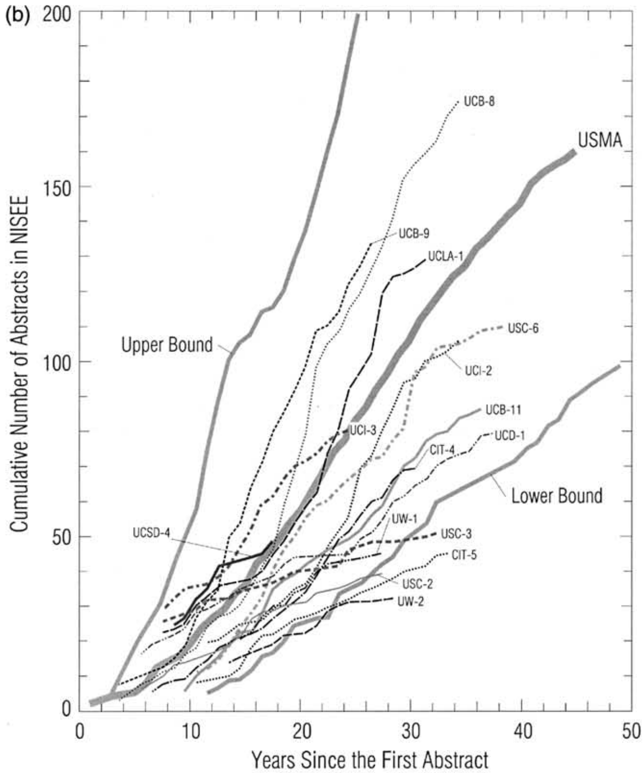
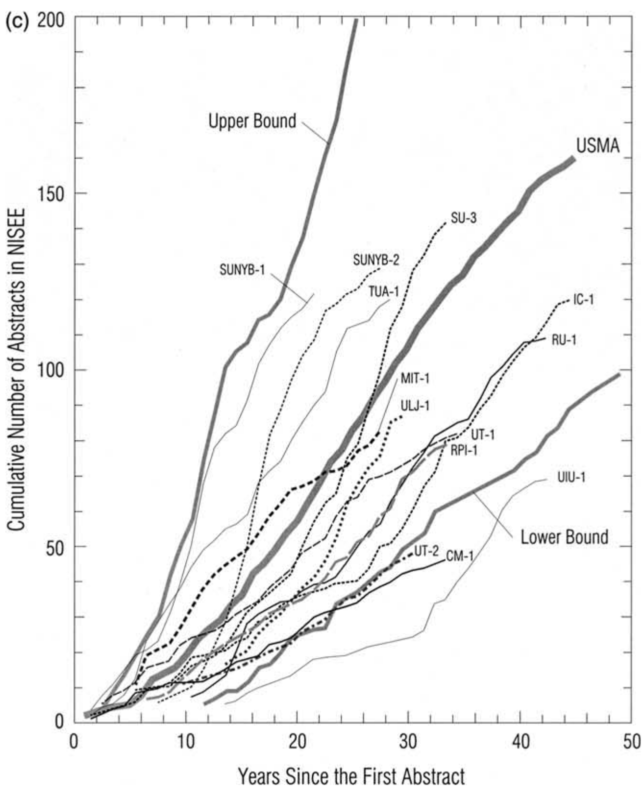


Fig. 2. (a) Cumulative number of abstracts (journal papers, reports, and conference papers) versus the number of years since publication of the first reported abstract, for 18 faculty in earthquake engineering. The upper bound (USC-7) and the lower bound (CIT-1) will be used as reference lines in the following plots. The average of cumulative publication rates of American male faculty in engineering and science, USMA, is shown for comparison. (b) Cumulative number of abstracts (journal papers, reports, and conference papers) in the NISEE database versus the number of years since publication of the first reported abstract for 14 faculties in earthquake engineering. The upper and lower bounds from Fig. 2a are shown with wide lines. The average of cumulative publication rates of American male faculty in engineering and science, USMA, is shown for comparison. (c) Cumulative number of abstracts (journal papers, reports, and conference papers) in the NISEE database versus the number of years since publication of the first reported abstract for 13 faculty in earthquake engineering. The upper and lower bounds from Fig. 2a are shown with wide lines. The average of cumulative publication rates of American male faculty in engineering and science, USMA, is shown for comparison. (d) Cumulative number of abstracts (journal papers, reports, and conference papers) in the NISEE database versus the number of years since publication of the first reported abstract for 11 ‘younger’ faculty in earthquake engineering. The upper and lower bounds from Fig. 2a are shown with wide lines. The average of cumulative publication rates of American male faculty in engineering and science, USMA, is shown for comparison.





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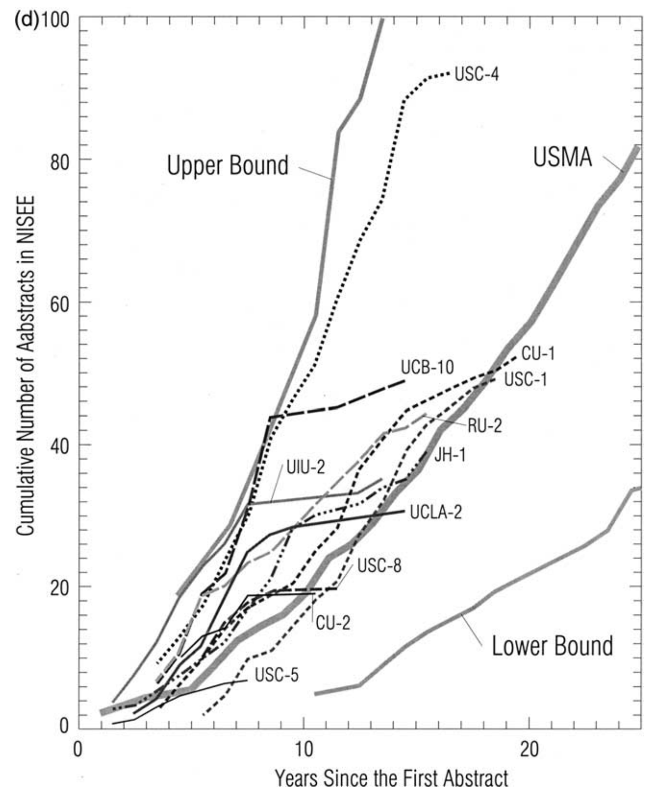

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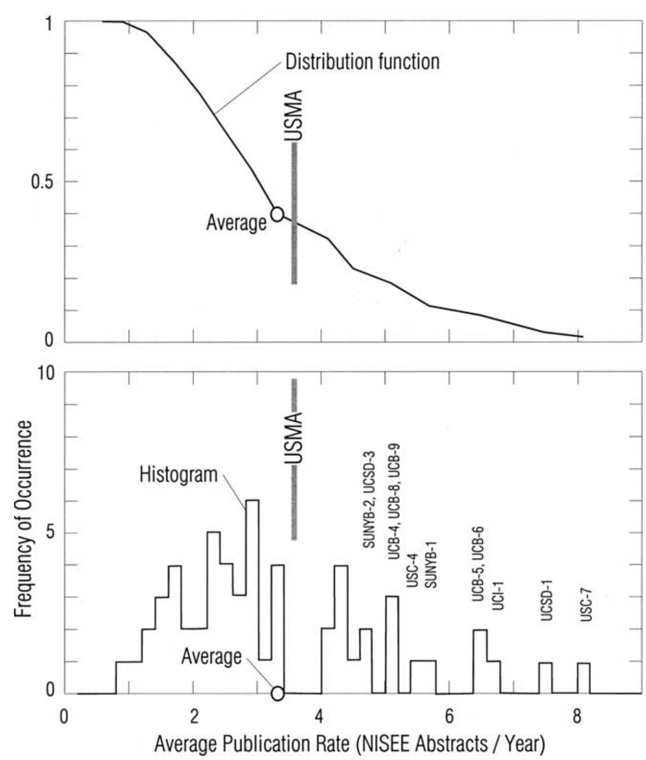

Fig. 3. Distribution function (top) and the corresponding histogram (bottom) of publication rates for the 57 faculty in this study. The average for this group is $x_t = 3.34$ NISEE abstracts per year. The corresponding USMA publication rate per year is 3.57.

rate of $\bar{x}_t = 3.34$ abstracts per year is representative of the productivity of senior faculty in earthquake engineering in the US. Considering only the non-retired members of the group—that is, 37 professors, 1 associate, 1 assistant, and 1

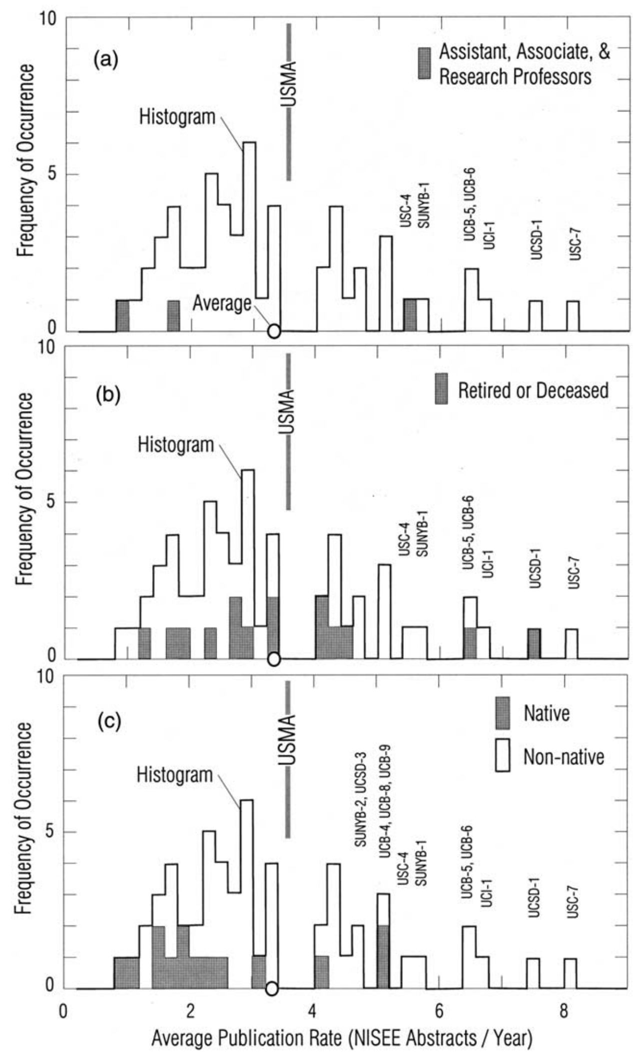

Fig. 4. Composition of the histogram of average publication rates, showing in gray the rates of (a) assistant, associate, and research professors; (b) retired or deceased professors and (c) native versus non-native professors. The average publication rate of American male faculty in engineering and science, USMA, is shown for comparison.

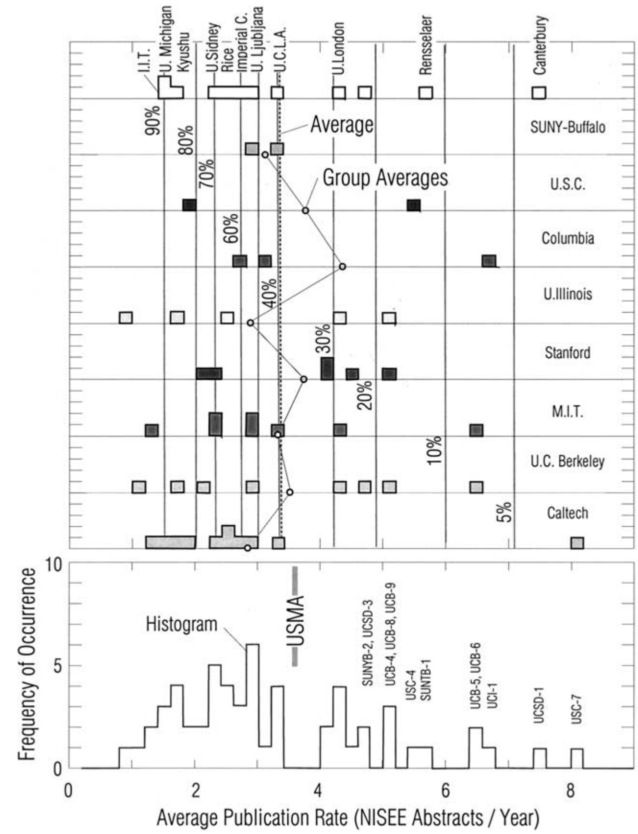

Fig. 5. Histogram of the publication rates (bottom) and its decomposition (top) according to the institutions where the 57 members of the sample faculty in earthquake engineering received their doctoral degrees. Vertical lines labeled 5, 10,…,80 and 90% indicate the overall distribution of publication rates for this sample. Group averages for Caltech, U.C. Berkeley, M.I.T.,…,overall average $\bar{x}_t = 3.34$, and USMA average at 3.57 abstracts per year are shown for comparison.

research professor (Fig. 4b)—results in an average production rate of $\bar{x}_{\text{active}} = 3.22$, which is essentially the same as the average publication rate for the entire sample of 57.

In terms of citizenship at birth, 42 (74%) of the sample of 57 were born outside the United States, and 15 (26%) are native Americans (Fig. 4c). With respect to average productivity, again measured in terms of the abstracts in NISEE per year, these two groups are different: $\bar{x}_{\text{f}} = 3.58$ and $\bar{x}_{\text{us}} = 2.66$, respectively.

Fig. 5 shows the decomposition of the above histograms of the publication rates, according to the institutions where the 57 members of this sample received their doctoral degrees. Of the 57 professors, 11 have PhDs from Caltech, 8 from U.C. Berkeley, 8 from M.I.T., 6 from Stanford, 5 from Univ. of Illinois at Urbana, 3 from Columbia Univ., 2 from USC, 2 from S.U.N.Y.—Buffalo and one each from Illinois Inst. of Tech., Univ. of Canterbury, U.C.L.A., Univ. of London, Univ. of Sydney, Univ. of Michigan, Rensselaer Poly. Inst., Rice Univ., Imperial College in London, Univ. of Ljubljana, Technion , and Kyushu Univ. Vertical lines in the top part of Fig. 5 show the percentiles of the cumulative distribution of the publication rates for this group. Group averages for Caltech, Univ. of Illinois, and S.U.N.Y.—Buffalo are slightly below the overall average ($x_t = 3.34$), while those of U.C. Berkeley, Stanford, Columbia, and U.S.C. are above the average. We note these averages for completeness in this presentation only. The sizes of all samples are too small for the results to be considered significant.

4. Comparison with national trends

To compare publication rates in earthquake engineering, as sampled for 57 faculty in this study, I used the mean publication trends among university professors for the period between 1960 and 2000, as reported by Bozeman and

Lee [9] (see Appendix A). By integrating their data on the mean number of publications per year, starting when the faculty received their doctoral degrees (see Fig. A2), I calculated the mean of the cumulative number of publications versus years since doctoral degree, or approximately versus time in years since the time of the first abstract included in the NISEE database. Thus computed, the cumulative number of papers is plotted in Fig. 2a–d and is labeled 'USMA' (United States male average). The average slope of the USMA curve is about $\bar{x}_{\mathrm{usma}} = 3.57$ papers per year, essentially the same as $\bar{x}_{\mathrm{total}} = 3.34$ for all of the 57 earthquake engineers in this study.

Bozeman and Lee [9] found considerable disciplinary differences in the number of publications during the researcher's life. Chemistry (10.6% in their sample) is the highest producing discipline, and computer science (5.6% in their sample) has the fewest publications. Because engineering professors were the largest group in their study (41%), in this work I have assumed that the USMA curve (Fig. 2a–d) can be used as an approximation of the average publication rates for male engineering professors in America. Thus, the result implies that the productivity of professors in earthquake engineering is essentially same as the average productivity in other fields of engineering in the United States.

Bozeman and Lee [9] found considerable differences in publication rates among assistant, associate and full professors (2.82, 3.25, and 5.15 papers per year, respectively). Our sample of 57 professors is biased toward senior faculty—54 versus 3, and so we cannot compare our trends with Bozeman and Lee [9]. Our results in Fig. 4a, nevertheless, are in qualitative agreement with their finding.

For the sample of 57 earthquake engineers, we found the average publication rate for non-native faculty to be $\bar{x}_{\mathrm{f}} = 3.58$ abstracts per year and for the native faculty $\bar{x}_{\mathrm{us}} = 2.66$. This corresponds to a factor of 1.35, which means that non-native faculty in earthquake engineering produce about 35% more publications per year than the native faculty. Bozeman and Lee [9] noted a similar trend, but a smaller factor, equal to 1.24.

5. Conclusions

The principal finding of this study is that the publication rates of senior professors in earthquake engineering are close to the national average publication rates in engineering and the sciences in the United States. I found this rate to be $\bar{x}_{\mathrm{active}} = 3.2$ abstracts (papers) per year for the 40 active professors in earthquake engineering. Bozeman and Lee [9] study of 443 university professors, who are not retired professors, led to $\bar{x}_{\mathrm{usma}} = 3.4$ papers per year. Therefore, the publication productivity rate alone cannot be the reason for the absence of earthquake engineers from the HighlyCited.com list of most cited and influential researchers in engineering.

Appendix A. Mean publication trends among university professors between 1960 and 2000

In late 2001 and early 2002, Bozeman and Lee [9] conducted a survey of the careers of 443 scientists and engineers. The survey was sent to university faculty members who are not retired professors or industrial researchers. Among the respondents, 41% (181) were engineering professors, 15% (66) were bioscience professors, 5.6% (25) were computer science professors, 10.61% (47) were chemistry professors, 9.7% (43) were physics professors, and the remaining 12.9% (57) were other science field professors. By group, tenured faculty were 62.8% (278), non-tenured faculty 37.3% (165), male 86.5% (383), female 13.1% (58), native scientists 68.4% (303), and immigrants 31.4% (139). The average age of the sample was 46 in the year 2000. In particular, the gender ratio and native/immigrant ratio in this sample is very close to the national level. Their results are summarized in Figs. A1 and A2. The 'normal count' measures the total number of published refereed scientific articles and books. Fig. A2 shows the mean number of publications after researchers received their doctoral degree. This figure gives insight into productivity levels during the course of a researcher's career.

The data show that productivity peaks between the 23rd and 28th year, averaging nearly five publications per year. After that period, the researcher has four publications for about 5 years or so, and then the average drops to a little more than two after 40 years. The average is less than three publications for the first 8 years—the time during which many researchers are struggling to qualify for tenure. Table A1 shows productivity by rank, marital status, citizenship, and gender. To make the figures comparable, the measure is median publications between 1996 and 2000, dropping individuals who did not have doctoral degrees by

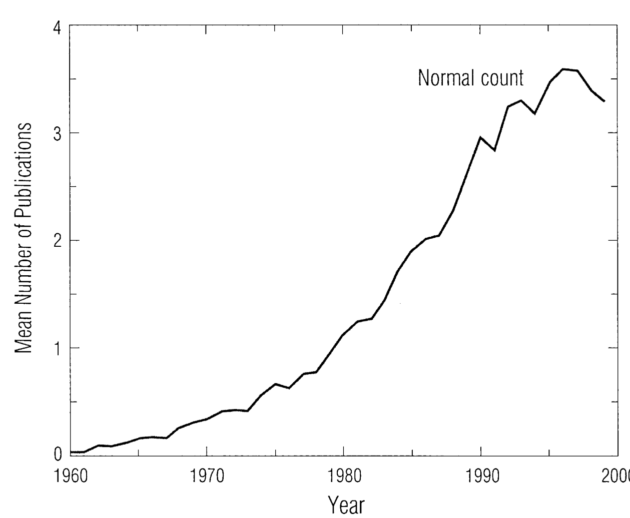

Fig. A1. Mean number of publications between 1960 and 2000.

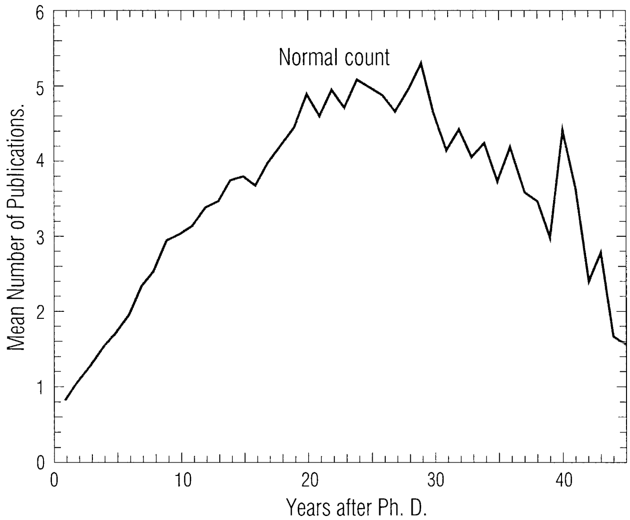

Fig. A2. Mean number of publications versus years after PhD.

Table A1
Productivity in terms of mean publications per year (normal count)

Productivity by rank	Full professor 5.15	Associate 3.25	Assistant 2.82
Productivity by marital status	Married 3.91	Single 2.59	
Productivity by citizenship	Native 3.55	Non-native 4.34	
Productivity by gender	Male 3.96	Female 2.75	

From Ref. [9].

1996. By normal count, the discrepancy between full, associate, and assistant professors is considerable, with more than five per year for full professors and less than three for assistants.

Using the same indicator—productivity since 1996—Bozeman and Lee [9] find that other demographic factors are importantly related to productivity. As Table A1 shows, married researchers, non-native researchers, and males are more productive. Using *t*-tests of significance, rank, gender, native status, and marital status are all significantly associated with productivity. Finally, Bozeman and Lee [9] note that other variables positively and significantly associated with normal counts of productivity include the total number of doctoral students currently supported, self-reported job satisfaction, and a perception that department colleagues appreciate one's work.

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