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Commentaries

The geography of scientific citation

As the marketplace for research and education becomes ever more global, there is growing interest in international comparisons of standards and quality in different countries and places. Rankings of universities according to various criteria, ranging from the quality of the educational experience imparted, to their research prowess, have become regular news items in English-speaking countries (University of Illinois Library, 2002). In some countries such as the United Kingdom where the core funding of universities comes from central government, such assessments are now used routinely for resource allocation (HERO, 2002).

International comparisons are difficult, however, with few published rankings despite rapidly increasing international migration to pursue research at the graduate level. In the USA 20% of all full-time graduate students are non-US citizens (NCES, 2002); in the United Kingdom the comparable figure is 25% (HESA, 2002). As there are no global rankings, most decisions to pursue research at a particular institution must be based on casual perceptions of quality, cost, and overall value for money. To examine the research quality of universities worldwide, citation indices provide a first approach to the problem (Oswald, 2002). The ISI's HighlyCited database (http://www.isihighlycited.com) which is currently (December 2002) composed of the top 100 or so cited individuals in fourteen scientific fields is a manageable source for classifying scientists not only by their field but by their institution, their location, and the country in which they work.

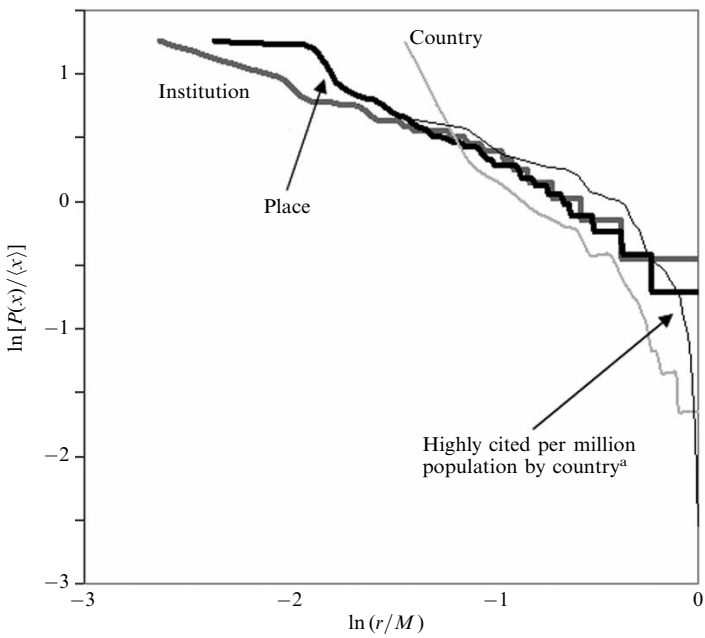
This source has many limitations, for it excludes mathematics (other than physics), the social sciences, and the humanities, and is thus biased towards the medical sciences. Moreover, it is under rapid development with the size of the database planned to increase to twenty-one subject area categories with over 4500 names by the end of 2003. There are also limitations to the 'institution' data with respect to joint, part-time, and related appointments which clearly complicate any indices we may derive (M McVeigh, private communication, 2003, Institute of Scientific Information, Philadelphia, PA). Nevertheless, I consider that a preliminary analysis is worthwhile and I have taken data from twelve of the fourteen categories listed. From a detailed scrutiny of each entry, I have used data on 1222 scientists. A significant minority of the scientists cited—some 30%—work in research institutes, hospitals, and private firms, albeit many connected to university institutions, but to maintain comparability between cities and countries, I have retained these data.

The pattern of concentration that this analysis reveals is remarkable: 1222 scientists work in 429 institutions which are located in 232 places in 27 countries. Almost half these scientists are in 50 institutions in 5 countries, most being in the United States. In table 1 (see over) I list the top 20 institutions in terms of the number and percentage of scientists cited. These institutions contain nearly 30% of the scientists, and are all located in the USA with the exception of University College London and the University of Cambridge. The concentration increases as the data are aggregated from institution to place and thence to country. In figure 1 (see over) I show these aggregated data sets as Zipf plots where I have plotted the logarithm of the number of scientists for each institution, place, and country, normalised by their means, against the logarithm of their normalised ranks. Collapsing each data set in this way shows quite clearly how the

Table 1. Top twenty ranking of instituting by number of highly cited scientists.

Rank	Research institution	Number of highly cited scientists	Percentage of highly cited scientists
1	Harvard University	52	4.3
2	Stanford University	36	2.9
3	University of California, San Diego	30	2.5
4	MIT	26	2.1
5	NIH[a] National Cancer Institute	19	1.6
6	University of California, San Francisco	17	1.4
	Cornell University		
8	University of California, Berkeley	16	1.3
	University College London (UK)		
10	CalTech	15	1.2
11	NIH[a] Allergy & Infectious Diseases	13	1.1
12	Johns Hopkins University	12	1.0
	University of Cambridge (UK)		
	University of Washington, Seattle		
	Washington University, St Louis		
16	University of California, Davis	11	0.9
	University of Texas Cancer Center		
18	Michigan University	10	0.8
	Northwestern University		
	Yale University		

[a] NIH National Institute of Health.



[a] This is the plot for countries, normalised by population in millions, which illustrates a different pattern of concentration from the basic data. I have fitted linear plots to the basic data using $\ln[P(x)/\langle x\rangle] = k - \alpha \ln(r/M)$, where for institutions $\alpha = 1.049$ ($R^2 = 0.962$), for places $\alpha = 0.816$ ($R^2 = 0.938$), and for countries $\alpha = 1.997$ ($R^2 = 0.949$). All these values are significantly different from zero at the 99% level.

Figure 1. Rank-size distributions of highly cited scientists.

concentration increases as the data are aggregated into places and countries. I have fitted power laws to these plots based on $[P(x)/\langle x\rangle] \sim (r/M)^{-\alpha}$, where $P(x)$ is the number of cited scientists at rank r, $\langle x\rangle$ is the mean number of cited scientists, and M is the number of institutions, places, or countries for each of the three respective aggregations (Redner, 1998). The value of the power α is related to the degree of concentration.

In table 2 I show the top ten countries in terms of the number of scientists and places where they work. The ratio of scientists to places provides another measure of the concentration, with the implication that the larger the number of highly cited in each country, the more likely they are to be highly concentrated in a small number of places. If we normalise the data by population, we get a slightly different picture; the top five are now Switzerland, United States, Sweden, United Kingdom, and Israel with smaller countries becoming more significant. We might even consider normalising by the square of population, reflecting the potential interaction within a population although, for the scientific enterprise, this probably is not a good measure of where such interaction is possible. All this does is to sharpen the index even further, with small countries dominating. Similar analyses for institutions and places are more complicated as the choice of a population for the normalisation is uncertain. College towns begin to dominate, for example.

Table 2. Top ten ranking of countries by highly cited scientists.

Rank	Country	Number of highly cited	Number of places	Concentration: scientists/places	Highly cited per million population
1	United States	815	90	9.06	3.16
2	United Kingdom	100	24	4.17	1.72
3	Germany	62	21	2.95	0.78
4	Canada	42	15	2.80	1.53
5	Japan	34	14	2.43	0.27
6	France	29	11	2.64	0.50
7	Switzerland	26	5	5.20	3.78
8	Sweden	17	2	8.50	1.96
9	Italy	17	10	1.70	0.29
10	Australia	17	9	1.88	0.96

A particularly graphic indication of the basic pattern is illustrated in figure 2 (see over) where I have mapped the main locations of places by circles proportional to the number of cited scientists. Of the most highly cited scientists 40% work in 10 places of which 9 are in the USA. These locations bear out our perceptions of where the world's top institutions are most heavily concentrated: on the west coast of the United States, the Boston – Washington megalopolis on the east coast, central London, Chicago, and interestingly in the cluster of towns around Research Triangle Park in North Carolina. I have not yet examined the local detail of where these institutions are located, but casual knowledge suggests that these are even more highly clustered at ever finer scales. For example, the institutions in Boston are all within a two-mile radius of the MIT Museum whereas in London they are within a three-mile radius of the British Museum. At an even more local scale in central London, for example, the majority of the scientists cited are located within half a mile of Euston station in Bloomsbury.

This analysis is of course limited by the bias in the ISI data to English-speaking countries, to the medical sciences, and to full-time research rather than education. Although for US institutions, there is only a 40% correlation with the top 50 universities in terms of doctoral programs most recently ranked by *US News and World Report* (2002), this simply indicates the fact that size is all important in the rankings produced

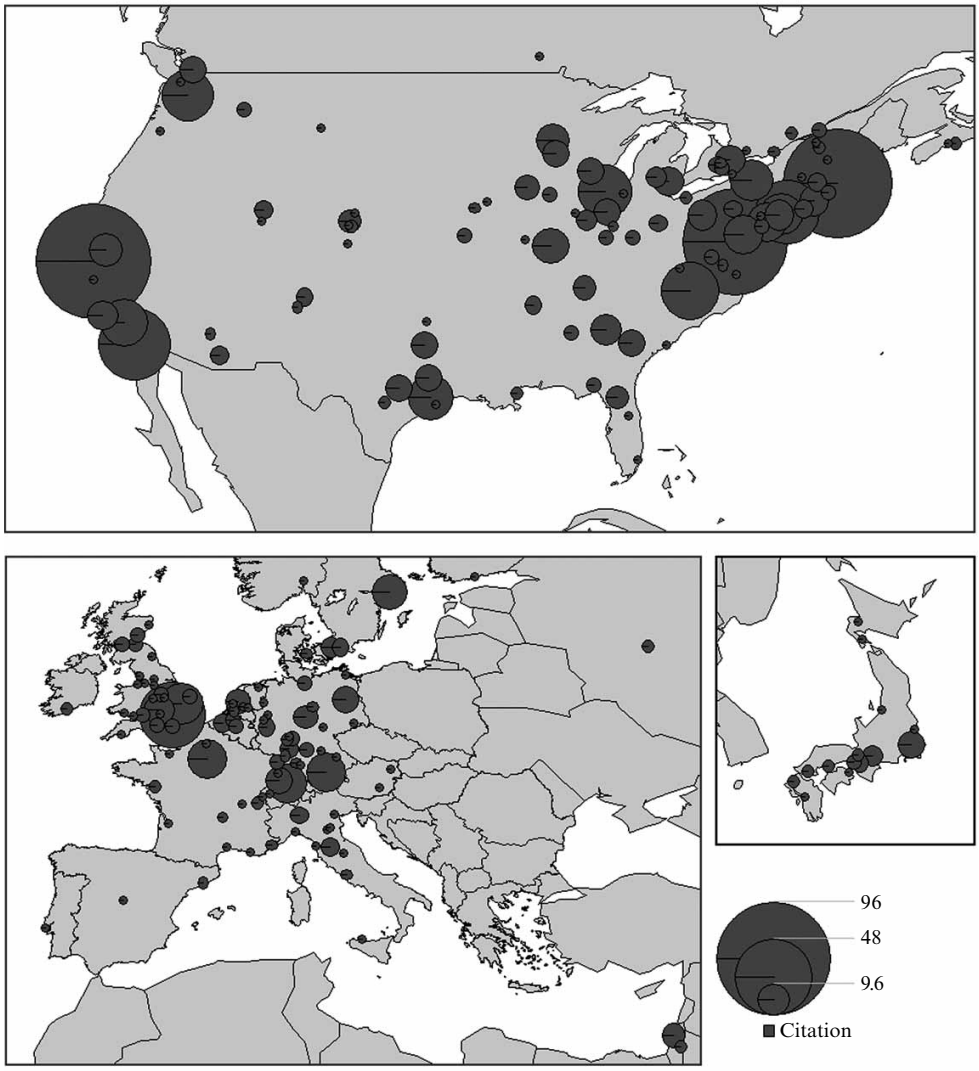


Figure 2. The geographical distribution of the highly cited.

from the ISI data. The correlation in the United Kingdom with *The Times* newspaper (2002) ranking is much the same at 43%. What this analysis reveals is a pattern of much greater concentration than I originally anticipated from other literature on the geography of the modern economy, notwithstanding the influence of history and the effects of national policy on the location of research centres (Matthiessen and Schwarz, 1999).

I consider there are important implications from these findings for national educational policy, and the distribution of research resources, especially during a period when governments and institutions are competing ever more intensely to gain and retain the best, and to build critical mass. There are issues involving the choice of the best graduate schools implied in the analysis. This analysis puts the geographical distribution of scientific wealth in perspective (May, 1997). In a British context it will be surprising to many academics and politicians that, of the 1222 scientists cited, only 100 (about 7%) are located in the United Kingdom based in 38 institutions (about 9%) of the 429 associated with these citations.

Considerably more work can be done with this source for within the next 12 months much more data over a wider number of fields will be available and it will be possible to mine the data for changes in citations at the margin. We do not yet know how robust these indicators of geographical concentration actually are, although I suspect that they will not change very much on an annual basis. I also suspect that from year to year there may be considerable volatility in the actual names of those who form the HighlyCited database but that once we aggregate these across institutions, places, and countries, such volatility will begin to disappear. However, what we are most interested in is how different places and countries are changing over decades rather than years for this will give us some index of how patterns of global research quality are changing which is of central importance to science policy everywhere. These analyses will be forthcoming in due course.

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The difference that planning makes

That was then, this is now

Urban and regional planning anticipates and manages the spatial consequences of economic and social activity and environmental change. In most developed countries it takes three principal forms:

1. development control centring on the regulation of land uses and built environments at the local scale;
2. assessment of environmental and social impacts of proposed development activity at the local and regional scales;
3. strategic planning involving the coordination of public and private investment and of government regulation within particular spatial frames.

Practically speaking, much of the everyday work of planning is managing change, or proposals for change, at the local and regional scales.

This describes what planning does. But it does not tell us what planning achieves, other than the maintenance of its own institutional processes. What are the consequences of planning? What are the results of 'coordination', 'control', and 'assessment'? In what ways, and to what extent, is society improved by these activities? In what ways, and to what extent, would society be poorer or less amenable without them?

There are some traditionally taught answers to some of these questions. Planning improves 'amenity' and it provides for 'orderly' and timely urban development (Cullingworth, 1964). But these are answers to old questions, about forms of planning that either no longer exist, or no longer have relevance, at least not in contemporary Australia from where I write. Here, and in many of the other British Commonwealth countries that adopted forms of 'town and country planning' during the 20th century, planning has evolved in response to new sociopolitical expectations and to new understandings of environmental and social processes. These changes have been registered in a variety of ways, some of them subtle, others more dramatic in scale and effect. New Zealand cast aside its entire 'town and country planning' regime in 1991 in favour of a new environmentally focused planning regime, framed by a Resource Management Act. Australia's State of Queensland followed suit, introducing a new Integrated Planning Act in 1997. Not all planning domains have been responsive to transformative pressures, however. Some, which shall remain nameless here, have continued to refuse demands for change and remain cloaked in closed and archaic values and practices.

Planning, or at least its rationale, has been transformed in recent decades by three principal forces. First, it is now set firmly beneath the rubric of 'sustainability'. The increased significance of this uncertain and contested term has signalled new demands upon professional competencies, and upon regulatory and institutional capacities. In many contexts, planning undertakes a much more thoroughgoing environmental assessment of change than it previously did. Allied to this, have been heightened expectations about planning's role as a public, and therefore democratic, process for managing social and environmental change. New democratic forces, among them the environmental movement, have emerged in recent decades to demand of planning a more participatory approach that respects key social values, such as fairness, tolerance, and inclusion (Sandercock, 1998). In the early 1970s, a unique alliance between construction sector unions and environmentalists in Australia placed 'green bans' on developments that had been rubber stamped by conventional planning processes. In the USA, a grassroots 'environmental justice' movement has mobilised in recent decades to challenge the objectivity and social purpose of institutional planning processes.

Third, governance in Western countries has been transformed generally by the rise of neoliberalism, which is now deeply entrenched in public sector thinking and activity. The neoliberal project, although contested, has undoubtedly altered the values and the decision criteria which frame public policymaking and government spending, especially in the English-speaking world. One important consequence is the increased significance given to economic values, such as 'contestability' and fiscal 'prudence', in the key decisionmaking frames of government (Self, 1993). In some countries, including Australia, growth in community expectations of governments, including the delivery of new services and amenities, has exceeded increases in public revenue.[1] More than

[1] Arguably, another consequence of neoliberalism, which has acted both to reduce the overall public revenue stream and to stymie attempts to broaden the tax and excise base.

ever, new proposals for government endeavour, including regulation and strategic activity, have to be tested against the strict opportunity-cost and 'business-case' criteria imposed by treasuries of national and regional governments.

Two decades of neoliberalism have diminished but not destroyed the possibilities for progressive policy initiatives, but their rationale must now be articulated within the specialist language of the economist and the financier. For planning, in competition with other sectors for scarce public resources, this raises new expectations of enhanced economic and financial literacy. Planning has been cast as a restraining hand on neoliberalism (Gleeson and Low, 2000). But it cannot exercise such restraint without first strengthening its arm by learning the language of finance and by deploying its own political economic case for stronger spatial governance.

The environment of planning: an Australian view

These forces for change have challenged the conceptual and operational bases for planning, causing some observers (for example, McLoughlin, 1994) to believe that planning is undergoing an 'identity crisis'. Others point to the new intellectual and technical challenges that these shifts are creating for planners and other urban professionals. Lyndsay Neilson, Secretary of the State of Victoria's Department of Infrastructure, observed recently that:

> "The changing context in which our societies are evolving places new pressures on all the professions engaged in managing urban and regional development and the built and natural environments. The complexity and interrelationships of issues facing planners today lie far beyond the simple town planning frameworks of much of the past 50 years..." (Neilson, 2002, page 97).

These dynamics have also intersected with more general reform currents in governance—notably, emphasis on policy integration across traditional portfolio boundaries—to produce new legislative and strategic frameworks for planning. Three contemporary Australian examples stand out: the 'planFIRST' proposals for integrated local and regional plan making in New South Wales; Queensland's Integrated Planning Act, 1997, and the Australian Capital Territory's proposed 'Canberra Plan'. All reflect a convergence of the integration agenda with the environmental and social critiques that have sought to transform planning by enlarging its domain of interest.

Along with these more challenging trends, however, have been a number of sociopolitical shifts that have enhanced both the awareness of, and the potential status of, planning in government and in the broader community. Briefly, these include:

(a) increasing recognition amongst governments and communities of the need to anticipate and manage better the consequences of globalisation and economic growth at the local and regional scales, within clear spatial frameworks;

(b) continuing scholarly and professional critique of 'aspatial' economic frameworks, which have demonstrably failed to equip governments to understand and prevent local and regional imbalances in living standards and in environmental quality.

(c) heightened sociopolitical awareness that the solution to global ecological deterioration—especially global warming—requires stronger intervention in growth processes to reduce the 'ecological footprint' of cities and urban regions.

In summary, planning has been challenged in recent decades by sociopolitical and policy agendas that have created new demands and new opportunities for this governance mode (Gleeson and Low, 2000). The political and institutional resurgence of planning has been noted in Europe, where enhanced spatial governance has emerged as a leading object for the European Union (Balchin et al, 1999). In Australia, there is evidence of a strong revival of State government and community interest in planning,

especially strategic and regional planning. This renewal has been registered in a number of ways, including new spatial governance frameworks proposed for, or already implemented in, some States and through the development of new metropolitan strategies (Melbourne and Canberra).

Self-awareness of planners and planning agencies

And what of planners, are they aware of the contribution that their professional enterprise makes to society? The evidence is that many in the Australian profession lack awareness of the purpose for planning—viz, its sociopolitical and scientific rationale—and of the consequences of planning. To the extent that awareness exists, it seems largely framed by a vague consciousness of traditional planning objects (amenity, order) and by loosely grasped notions of newer values (sustainability, participation).

More importantly, to what extent are public planning agencies able to articulate and promote the contribution that planning makes within the wider spheres of government and within the community more generally? Also, do they possess the skills and the analytical resources to monitor and evaluate the net benefits of any new proposal to strengthen or reform planning frameworks?

In Australia, Spiller (2002) believes that deficiencies in planning education partly explain the inability of many planners, and therefore planning agencies, to mount sound economic and financial cases for spatial regulation. This echoes, to some extent, McLoughlin's long-standing complaints (for example, 1992; 1994) about the inadequacies of Australian planning education, especially its failure to train students in two key technical skills: spatial analytical methods and political economic analysis. Taken together, these criticisms suggest that planning education and professional training do not equip planners with the skills needed:

1. to evaluate the net impact of spatial regulation and intervention on community well-being and environmental quality, and
2. to identify and estimate the value of new interventions in ways that would secure strategic support for proposals within government and within the broader community.

The new support for planning that is evident in some quarters of government and, arguably, in the general community, will not be sustained if planning itself cannot articulate its contribution to society in the contemporary context. The new democratic credibility claimed for planning in some quarters will surely dissipate if its value cannot be measured and explained to communities. More specifically, three dangers seem apparent if planning, and planning agencies, remain complacent about the need to explain the difference that planning makes to social and individual well-being:

1. The successes of planning, and its contributions to enhanced social, economic, and environmental outcomes, will remain invisible or, worse, will be attributed to other factors (for example, industry innovation) and/or other institutional players (for example, private developers, road-building agencies).
2. The singular ability of planning to open up to democratic scrutiny the general resource-allocation processes and technical evaluation procedures of governments will not be realised.
3. The case for the improved resourcing of planning needed to restore spatial governance capacities will fail, especially when assessed against the more consciously analysed and rigorously stated arguments of other institutional claimants.

More generally, it might be observed that any complacency about objects and outcomes in any major sector of public activity is likely to be self-defeating in the long run. For planning, the issue is especially acute given the strong (some might

say too idealised) sense of purpose and contribution evident amongst other urban professional groupings, notably engineers and architects. In Australia, there have been professional and scholarly grumblings about the inability of planning agencies to assert their agendas within the wider spheres of government, especially within cabinet decisionmaking processes. It has been observed that State transport agencies, with their large capital budgets and strong sense of professional purpose, have been the real planning bodies, especially in the larger metropolitan areas where major road and rail projects have led broader urban development patterns (Searle, 1999).

Putting the zombies to rest

In Beck's schema (for example, 1997), the forces that are transforming planning, and its sociopolitical context, are the same progressive dynamics that are forcing a 'remodernisation' of the capitalist state and a break with the traditional verities of 'simple industrialism'. I have argued elsewhere (Gleeson, 2000) that planning has a key role to play in this contemporary 're-enlightenment' of governance. Beck decries the countermodernising forces that have worked historically to undermine democracy: notably the 'excessive rationalisation' of industrialism and its servant sciences, and the 'despotism' of unrestrained markets. Planning, remade, could be a powerful remodernising force. Planning cannot play this role if it lacks a strong self-awareness of its potential limits and of its potential contributions. The task of remodernisation requires critical self-awareness—in Beck's terms, 'reflexivity'—as a basic institutional value.

Ossified, complacent, and blanketed in technocratic minutiae: this describes still the condition of planning in some quarters. In this state it resembles the 'zombie institutions' of which Beck speaks with dread; the bureaucratic creatures "which have been dead for a long time but are unable to die" (1997, page 140). Planning must not be a senseless zombie. It must regain a sense of purpose, with reference to the new challenges and new agendas that are remaking its rationale and reframing and enlarging its potential contribution. *Great Planning Disasters* (Hall, 1980) are still possible, but capitalism without planning would be disastrous. The lesson it appears must be learned again, this time by planners. An important step towards a reanimation of planning is a new and rigorous attempt to define and measure its contribution to community well-being and to environmental quality. When planning can explain the difference it makes, it really will be different.

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