Science as a Global Public Good

LERU 20th Anniversary Symposium of the same title – 10th November 2022. Turning points in the argument in bold.

Geoffrey Boulton
(International Science Council and University of Edinburgh)

1. I want to explore what this formulation means, why it matters, how benefits are best derived from it, the personal and collective responsibilities that it imposes on us, as individuals and universities, and as an introduction to today's discussions.

2. **But first, I need to make some preliminary comments about science.** If you search the literature or Google for the meaning of "science", you either have 2-3 lines or 100 pages. The listings in figure 1 are typical of the shorter ones. Non are particularly satisfactory.

> Science consists of observing the world by watching, listening, observing, and recording. Science is curiosity in thoughtful action about the world and how it behaves. **NASA**
> Science is the pursuit and application of knowledge and understanding of the natural and social world following a systematic methodology based on evidence. **Science Council**
> The careful study of the structure and behaviour of the physical world, especially by watching, measuring and doing experiments, and the development of theories to describe the results of these activities. **Cambridge Dictionary**
> Science is a systematic endeavour that builds and organizes knowledge in the form of testable explanations and predictions about the universe. **Wikipedia**

Figure 1: Examples of short definitions of science

3. It is because science is a process. It should be a verb not a noun. It is a special form of knowledge that is captured by two fundamental activities that form its bedrock, and which are ultimately the source of its value as a global public good. They are:

   First - that knowledge claims and the evidence on which they may be based are made openly available to be tested against reality and logic through the scrutiny of peers;

   and

   Second - that the results of scientific inquiry are communicated promptly into the public sphere and circulated efficiently.

4. These are processes that characterize or should characterize almost all the studies that are pursued in universities and define the sense in which I use the term science, much to the annoyance of many anglo-saxon colleagues.

5.. The scientist is an artisan, not a high priest, and for me, these are the artisan's tools, norms that are the specific ethics our work. At the same time, as good citizens, we should work in ways that are consistent with the highest contemporary societal values, of integrity, equity, inclusivity, and openness.

6. Science seeks both explanations that are universally true, as in the behaviour of fundamental units of matter, and ones that are bounded by time or space, as in the past movements of continents or the behaviour of social groups. It seeks to verify what is stable in that very unstable compound that often passes for knowledge.

7. Openness to sceptical scrutiny is the basis of so-called "scientific self- correction". The provisional nature of scientific discovery is eloquently expressed here by the three sages shown in figure 2. Science can invalidate but cannot validate. Although scientists may search for truth, scientific knowledge remains provisional. Although the progress of research may diminish uncertainty, uncertainty will remain.

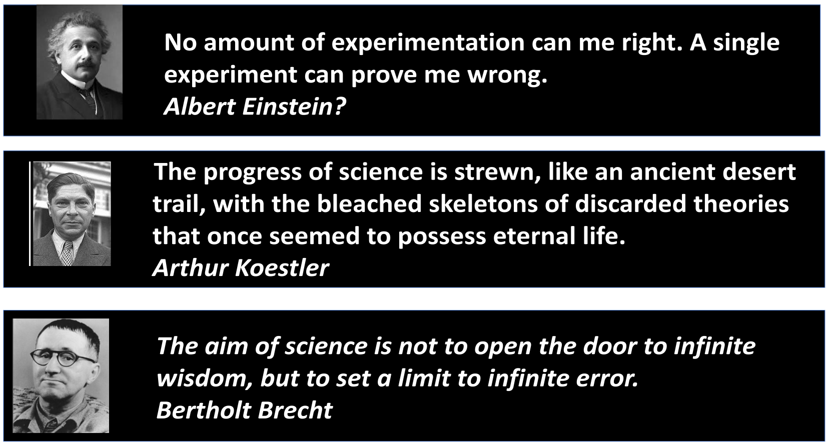


Figure 2. The provisional nature of scientific knowledge.

8. The word "scientific" is often, erroneously, used to imply "correct", "true" or "certain". It is a sad, but understandable fact that this is the view encouraged by our educational systems. Science, in contrast, and in reality, grapples with uncertainty.

9. In recent years, the relationships between this perspective of science and that of traditional or indigenous knowledge has been a matter of much debate. In my view, much individual and social knowledge, and so-called traditional or indigenous

knowledge, is “scientific” in spirit when empirical observations of repetitive patterns of occurrence or behaviour form the basis of general rules, which may be progressively adapted as exceptions to those rules are discovered. It is not science in the strict sense as it lacks the formalised rigours involved in publishing truth claims and related evidence as a basis for testing, sceptical review and possible invalidation. This is not to say that “traditional” knowledge is always less reliable than the scientific state of the art. It is sometimes superior, but in the long run, the scientific route wins.

10. Such distinctions matter. For example, some of you will know of the current difficult and often acrimonious debates in New Zealand about if and how modern science and traditional, Maori, knowledge should be related.

11. The discipline imposed by the constraints that shown on my first slide, not its sometimes anarchic methods, have made science the most reliable, though provisional, form of systematic human knowledge. It is not a dispensable luxury but has become essential to our societies and as a stimulus to curiosity, imagination and wonder. It helps all of us to make sense of and navigate the increasingly complex world we live in.

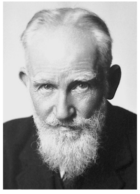
12. **Now let me relate this to the public good concept,** with “science as a global public good” having been taken as the vision of the International Science Council. The idea of shared, public goods has been a concern of moral and political philosophers since ancient times and in many cultures. It contrasts pursuit of the good of the many with the pursuit of narrow self-interest. It assumes that citizens stand in a relationship with one another which encourages them to create and maintain facilities or arrangements on the grounds that they serve common interests and produce public value, from which many individually benefit.

13. My thesis is that science should be treated as a public good, which leads to the question, “how is this public good best used to benefit the good of the public”. As you see, I make a distinction between the public good, what is good for the public, an abstract concept, and frequently contested, and a public good, which is concrete and finite. Its uncomfortable similarity needs some work by linguistic philosophers.

14. To an economist, public goods have a special meaning, that they are free at the point of use. They have two essential properties: firstly, consumption by one individual does not detract from that by another; and secondly, it is difficult, if not impossible, to exclude an individual from enjoying the good. Some artists have a similar view. (figure 3).

Joe Stiglitz

A public good has two critical properties:
Non-rivalrous consumption, the consumption of one individual does not detract from that of another,
and
non-excludability, it is difficult if not impossible to exclude an individual from enjoying the good.



George Bernard Shaw

If you have an apple and I have an apple, then you and I will still each have one apple,
but
if you have an idea and I have an idea and we exchange these ideas, then each of us will have two ideas.

Figure 3. The concept of public goods, from economics and the arts.

15. Public goods include such things as free education, free roads, an honest police force and the rule of law, which we may use for private benefit in, for example: enhancing job prospects; running a road haulage business; safeguarding possessions; and protecting investments from corruption. In its specific role as a global public good, science is a source of beneficial and applicable knowledge that is freely available and accessible world-wide. Public benefits are of course created from private sector research in many fields, but not generally as public goods. Public goods are the basis for most private goods and have proven to be amongst the most economically efficient forms of government investment. Under-supply of public goods limits efficiency by limiting the private benefits that could derive from them. The private sector inevitably under-supplies them. Without core public goods, the economy cannot function properly. `Good infrastructure, education and R&D are essential. Doing them badly is a serious drag on the economy.

16. But it is important not to see the utility of knowledge only though the limited lens of economic supply and demand. Scientific knowledge can enrich human perspectives in ways that cannot be captured on a balance sheet. Knowledge of distant galaxies or of deep time do not contribute to national economies but are profoundly enticing to the human imagination. Such knowledge, for its own sake, is a global public good.

17. **Let's now look at the interfaces of public good science with its users**. As for all public goods, science is most economically efficient, as a basis for private goods, when its findings are made readily and rapidly available to the largest number. **Science creates new possibilities, though usually in a form that is difficult to use, whilst complementary efforts, in business, government, in wider society, and by individuals, make those possibilities tangible, useable and socially and economically**

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profitable (crucial sentence which must be understood). This interface role of translating scientific knowledge into utility is a vital one, and helps to define where the public and private should meet, in order to deliver the greatest benefit; where should the interface be, and where has the private invaded the public or the public invaded the private to the detriment of benefit?.

18. Governments regard it as in the national interest to stimulate the creation of private goods from publicly funded scientific knowledge, but premature private appropriation of such knowledge impedes this process by depriving other societal and business actors of opportunities from which they might otherwise have benefitted. The costs of such appropriation can be high, particularly so for much basic research, where benefits are often widespread and potentials to stimulate further discovery are great. The location of the interface between public and private is therefore of first importance, as is determining the best way of delivering those public goods. Universities have a key role in scrutinising this boundary.

19. The potential commercial rewards for monopolistic capture of a significant segment of so-called "basic" science and technology are a temptation for private companies. I offer two recent examples of such potential capture in areas of great commercial interest.

    Firstly in the field of genetics where prior to a case brought before the US Supreme Court in 2013, more than 4,300 human genes had been patented, which could have led to private appropriation of a whole sphere of knowledge. However, the Court decided that because nothing new is created when discovering a gene (an interesting analogue to the colonization process), there is no intellectual property to protect, so patents cannot be granted. The ruling made all human genes accessible for all publicly and privately funded research and genetic testing in the USA.

    Secondly, many industry experts believe that excessively strong intellectual property protection has retarded the overall pace of innovation in the IT industry. This has been brought home in an anti-trust suit against Microsoft, which (it is alleged) has attempted to leverage the power associated with its control of the dominant operating system to a broader dominance in application software.

20. These are issues that make intellectual property rights a vital realm of continuing scrutiny, in ensuring that inefficiencies are not introduced by premature privatisation or delayed take up. Much of the new scientific knowledge adapted or created by the business sector is withheld from public scrutiny, at least in the short term, as a private good. The patents system permits the underlying concept to filter through to the public domain as a public good, whilst the patent holder retains the knowledge of

how best to transform it into marketable products, or to license that knowledge to others. Exclusive access to such patentable new knowledge enables a company to achieve a lucrative short-term market monopoly until it is caught up or overtaken by its competitors.

21. Intellectual property, patents and monopolization are key issues of great public significance. Publicly funded knowledge can stimulate private gain that in turn generates public goods of employment and economic wellbeing. At the present time however, processes are at work that can entrench monopolies, weaken competition, and create excessive pricing, that work against the public good.

22. A crucial public/private interface that I would argue is in the wrong place, and does not work well, is that between the research process and its communication through publication. The commercial science publishing industry effectively appropriates the public good potential of much science for premature private profit. Its business model was developed by Robert Maxwell in the last century, in his words as "a perpetual financing machine". It is a system in which publishers provide universities with deeply flawed indices of research assessment, which thereby ties researchers into the system, and to which the global scientific community provides more than 2 billion dollars per annum of direct free labour to the publishers' profits. Its consequences are to undermine science as a public good; to discriminate against the poorer parts of the global science community; to inhibit access to scientific results; to slow down scientific communication; and to inhibit scientific functionality and the potentials of digitalisation. It incentivises both researchers and their universities to distort the balance of scientific effort. It is as if the purpose of science is primarily to provide scientists with pleasant careers and to write yet more incomprehensible papers. Breaking out of this closed loop requires a coordinated push for reform, which may even now be building up.

23. The dynamic within our universities has been dramatically changed by the digital revolution of recent decades, that belatedly realised the vision of the Austrian-American business consultant Peter Drucker, about the primacy of knowledge, the stuff that is the central concern of universities, and is relevant again to our role as part custodians of the public/private knowledge interface (figure 40.

24. **In this new, data rich world, what are the principle ethical responsibilities of scientists and their institutions?** I believe that there are threefold absolute requirements: that we should expose the evidence for the truth claims that we make; disseminate our work in the public domain; and act to mitigate significant potential for hazardous use, and a fourth, fundamental, but dependent on circumstance, that of responding to the needs of society.

25. It is fundamental that published truth claim concurrently expose their evidence, the data, for scrutiny. Otherwise, the claim fails the test that it is "scientific". It is not always a requirement that is easy to satisfy in a data-rich world. There is a widespread failure to observe this principle, which has contributed to the so-called crisis of replication by making it impossible to test the replicability or even the honesty of published truth claims. It is not a requirement by many journals. It fails to recognise that the creativity of much research derives from the inspiration that a particular observation or measurement might reveal a novel insight into reality, and that data is a first-class output of scientific inquiry, often more important than the article that is built on it, and a potentially rich source of inspiration for further analyses or hypotheses. I call Charles Darwin as a witness (figure 5).

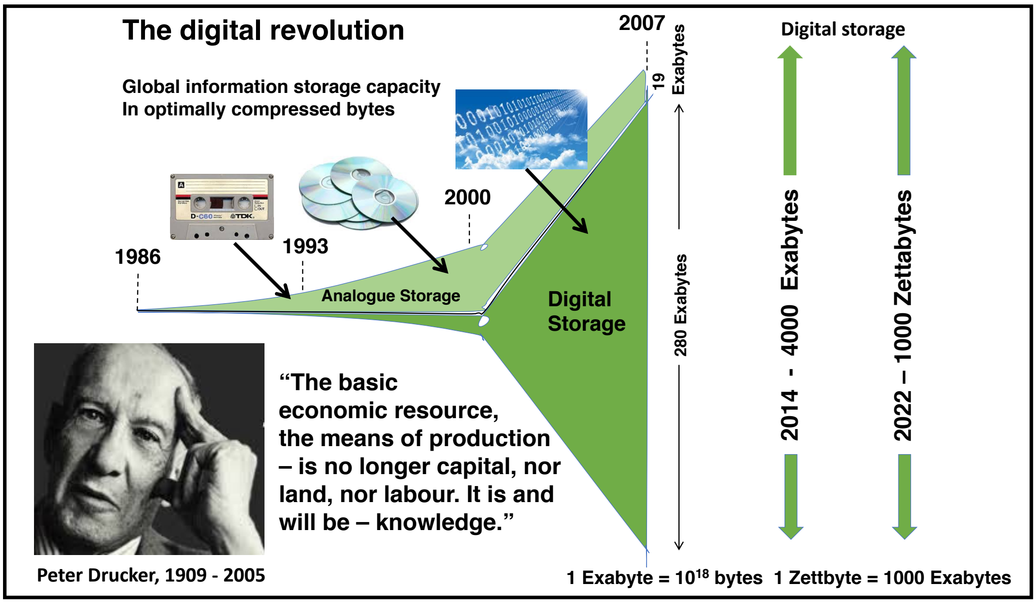

Figure 4. Peter Drucker and the Digital Revolution

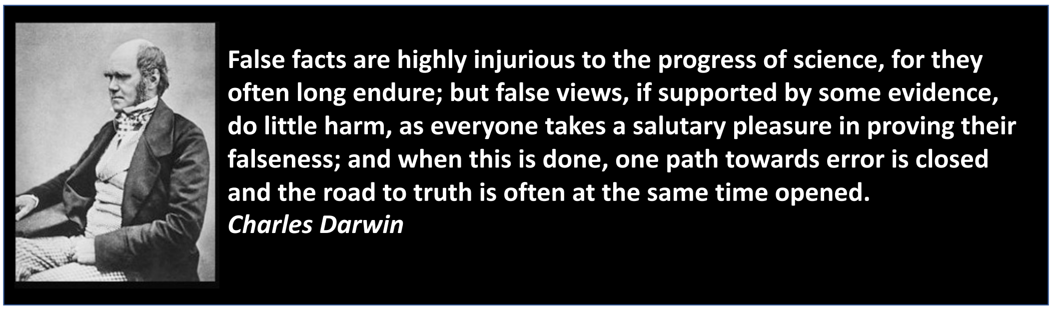

Figure 5. Why data matters.

26. Science is communicated formally through highly regulated publications, and informally as essential contributions to public discourse, debate, problem solving, innovation, education, and governmental policy. Bibliometric indices as measures of scientific value incentivize the former, often to the detriment of the latter.

27. This latter has become crucial. The digital revolution’s creation of ubiquitous communication devices and the web have together produced a more complex, crowded communications environment, with many more voices competing for attention. It has democratised communications in ways that permit individuals and groups to by-pass traditional media gatekeepers of authorised wisdom and to broadcast their views, with minimal restraint, on the web and through social media. It has made information, misinformation, and disinformation immediate. And with the latter two tending to the more seductive.

28. Formerly, sources of information were known through journals, newspapers, radio and television. The web and social media have anonymised the sources of information. The absence of editorial responsibility has unleashed anonymous ferocity, with the brevity imposed by Twitter encouraging competing assertions rather than competing arguments.

30. These trends are encouraged by many media platforms. After the early euphoria that greeted digital devices, attitudes towards digital media and the companies that control them have shifted. There is a dawning realisation that the technology giants and the platforms they have created, including ones that started as scientific publishing enterprises, do not always serve the public interest. Not least in that many

business models are based on a refusal to accept significant responsibility for the materials to which their platforms.

31. The world of misinformation, disinformation and alternative facts will not be countered through formal publication. It is vital that we correct the balance by recognising and incentivising a wider range of communication modes. Painting science and knowledge production as parts of an elite conspiracy, as populist rhetoric increasingly does, is profoundly damaging to humanity's interests such that universities must promote science as a public enterprise, not an elite activity, undertaken behind library and laboratory doors.

32. **The different settings within which science is practised, in universities, institutes, government laboratories, the private sector, and by independent scientists (including citizen scientists) strongly condition the ways and the extent to which science serves the public good and how the responsibilities of scientists are exercised.** Some settings are unconstrained, with scientists being relatively free to choose research priorities. Others are constrained in these choices.

33. Universities generally uphold a convention of academic freedom, giving academic researchers unconstrained freedom to choose what to study, how to study, how best to communicate their findings, and freedom to express them, including those that are inconvenient to authority. To a great degree, those freedoms have enabled universities to be sources of our most profound understanding of nature and society, as enduring entrepreneurial centres of the modern world and storehouses of anticipatory knowledge for an unknowable future. Fifty years ago, university scientists who studied climate change, and I was one of them, had long hair and wore brightly coloured socks. We were regarded as irrelevant, but harmless. The Director of the UK Meteorological Office regarded our work as pointless. However, serendipitous investment in our work revealed processes that are now recognised as threatening the future of human society, whilst our successors are playing crucial roles in assessing how it needs to adapt. Without our discoveries, we would probably be unaware of the causes of climate change and therefore be unaware of where solutions might lie (of course, though we are aware of where solutions might lie, we still don't apply them, but that's another story).

34. There is a tendency to see "useful research" only as research directed towards contemporary problems and mobilised by "mission-driven" funding. Whilst mission-driven research is vital for immediate and foreseeable priorities, enlarging the breadth of human understanding through maintenance of curiosity-driven research is a fundamental contribution to humanity's store of knowledge and understanding. It is a vital investment in the future and a key role for the universities.

35. Can the remarkable global networks of which universities are part through the activities of their academics be mobilized for the global public good? Their contribution to many research-based issues is, I believe best done through their academic staff, but there are other crucial enabling links that would suited to inter-university actions.

36. Many of **t**he crises of the modern era, would best be served within a geopolitical frame where there is broad consensus as a basis for coordinated action. Instead, we have increasing social, political and ideological polarisation, characterised by diverging certainties that are inimical to the sceptical spirit of science, and where cooperating across ideological gulfs appears increasingly difficult, on one side, in Richard Feynman's words, a preference for questions that can't be answered, and the other side, for answers that can't be questioned.

In this setting, some national security services have increasingly sought to regulate and restrict international scientific cooperation on the grounds of national security. This trend towards "securitisation" could seriously damage or reverse the increasingly open and collaborative international science system that has developed in recent decades, with the potential to develop into a downward xenophobic spiral.

37. I would argue that a major international effort by universities, as a global collectivity, is called for, in which they re-double their efforts to maintain open, mutually supportive interactions, even during stand-offs between geo-political blocs. The response of universities to the Ukraine war being an example from which we must learn.

An evolving social contract: Open Science

38**. The role of science in serving the global public good responds both to new horizons that science itself creates and to emerging societal priorities as they evolve, thus influencing the nature of the social contract between them, and the social organisation of the scientific process itself.**

39. Many now believe that a new era of science is dawning, changing the way that science is done and enhancing its capacity for discovery, whilst deepening its relationship with societies. It is my argument that openness has proven to be the most efficient way of ensuring that scientific knowledge is a public good, and that the open science movement, which annually develops greater traction, is the means of ensuring this. It has developed primarily because the digital revolution of the last three decades has placed key enabling tools in the hands of scientists and the public.

40. Although the potential of open science has hitherto been largely conjectural the COVID-19 pandemic provided stark examples of its benefits in action. The Director of the US National Institute of Health commented: “I have never seen anything like this” - “the phenomenal effort will change science – and scientists – for ever”.

41. Although UNESCO has recently defined **how** Open Science should be organised. It has not been specific about its large-scale priorities. I would commend the following as specific priorities for a new era of Open Science:

1) Maximising the rigour, integrity and efficiency of science as a public good, through greater openness to scrutiny of its data and the research process. It is something we should all work for.

2) Implementing globally affordable and accessible communication. Science must be globally engaged and its publication systems must be means of maximising its public good on the global stage. Globally accessible publication is the basis for a truly international science community, which would benefit all, and the societies of which we are part.

3) Exploiting cross-disciplinary data to explore complexity. The advent of massive digital data volumes, modern high performing computing and AI algorithms permits us, for the first time, insight into complexity. Complexity is the stuff of major contemporary priorities such as global change and the SDGs. It has cracked biology’ grandest challenge, by Deep Mind’s gigantic leap of determining a protein’s 3-Dimensional shape from its amino-acid sequence. The cross-discipline data interoperability needed for the analysis of many systems systems is one of the great challenges of modern science.

4) Engaging with society for social relevance, utility and impact. Science must become a public enterprise if it is effectively to serve the needs of society, both regionally and internationally. It must not be seen as an elite endeavour.

5) Creating a global open science commons is the most ambitious perspective. It would add value to national science and address shared global challenges. The increased withdrawal into national silos that we currently experience should be counteracted by an expansion of scientific interaction globally, not a contraction.

42. And so, in conclusion, it is my view that the concept of science as a global public good is both a proper description of the scientific enterprise and a practical guide to action in many domains. I look forward to the following discussion.

3700 (31.6 mins)