

Grand Challenges

Bibliography of sources that list grand challenges, research frontiers, agendas and priorities with an emphasis on cutting-edge issues in research, development, science, policy and planning, among other areas of interest. The tradition of Grand Challenges is common in many scientific disciplines, more so in the so-called hard sciences (physical and life science) than in the soft (social) sciences.

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Updated November 2010, suggestions welcome.

EXAMPLE OF CRITERIA USED TO DEFINE/SELECT GRAND CHALLENGES

Source: International Council for Science. 2010. Grand Challenges in Global Sustainability Research: A Systems Approach to Research Priorities for the Decade. Paris: International Council for Science.

1. **Scientific importance.** Does the question address a cutting-edge research challenge that, if answered, could significantly advance our understanding within the next decade of how to achieve global sustainability?
2. **Global coordination.** Is a coordinated international or global approach involving multiple researchers in different regions and often in different disciplines needed to answer the question? If not, then such a question would fall to others (i.e. be outside the remit of this framework, despite its importance to a given field).
3. **Relevance to decision makers.** Will the answer to the question help to inform actions to meet urgent global social and ecological needs, especially promoting sustainability, reducing poverty, and assisting the most vulnerable in coping with global environmental change?
4. **Leverage.** Does the answer to the question involve a scientific or technical breakthrough, or would it create a transferable theory, model, scenario, projection, simulation or narrative that would help to address multiple problems or other challenges related to global sustainability research?

Urban and Regional Planning

Urban and Regional Planning (Allen 2003; Blanco, Alberti, Forsyth, Krizek, Rodríguez, Talen, and Ellis 2009; Chapple and Lester 2007; Douglass and Friedmann 1998; Friedmann 2002; Friedmann 2005a; Gottlieb 2005; Ozawa 2004; Pastor 2000; Rodwin and Sanyal 2000; Sandercock 2003; Wheeler 2002)

Urban planning and public health (Cohen 2005; Corburn 2004; Northridge and Sclar 2003)

Environmental planning/mgmt of the peri-urban interface: (Allen 2003)

Scholarly Associations of Planning Schools: GPEIG GPEAN WUN (dialogues) (Browder 2006; Friedmann 2005b; Stiftel and Watson 2005; Stiftel, Watson, and Acselrad 2006)

Regional science and planning: (Bollman 2002; Markusen 2004)

Network society (Albrechts and Mandelbaum 2006; Castells 2000; Esty and Ivanova 2006)

Sustainable cities, Green cities (Ravetz, Sustainable City-Region Working Group., Town and Country Planning Association (Great Britain)., and Robert 2000; Register 2002; Satterthwaite 1999; United Nations Human Settlements Programme. 2009; Wheeler 2004; Wheeler and Beatley 2004)

Urban ecosystems (Berkowitz, Nilon, and Hollweg 2003)

- Bish Sanyal, one of GPEIG founders and most enthusiastic advocates, has written an excellent article titled “Planning’s Three Challenges.” The three challenges call for: (1) integrating spatial and socioeconomic planning, (2) constructing planning theories to meet the needs of planning practitioners, and (3) rejustifying government intervention (Sanyal 2000).
- Leonie Sandercock’s work on urban futures focuses on the challenges of multiculturalism in ethnically diverse cities. In her book *Cosmopolis II: Mongrel Cities in the 21st Century*, Sandercock outlines five qualities/sensibilities necessary for a “new planning imagination for the 21st century: political, therapeutic, audacious, creative and critical” (2003 :209). Finding ways to foster this new planning imagination is a major challenge for progressivism.
- John Friedmann is one of the planning academy’s most prolific authors. His life time of work (over 20 books) consistently seeks paths to the good society. Friedmann prioritizes challenges for urban and regional development from a critical perspective that aims to empower civil society and enable (as a fundamental human right) *a flourishing of human/civil life in association with others*. Friedmann’s normative theory of alternative development is intended to serve the needs of poor and disempowered people. From a household level of analysis he puts a premium on finding ways to increase the urban and rural poors access to resources (*bases of social power*) (Friedmann 1992). From a macro perspective, Friedmann (2002) calls attention to three pressing challenges: (1) enabling progressive regional governance, (2) creating regional wealth through endogenous development based on principles of sustainability, and (3) promoting integrated and sustainable development of macroregions through intercity/regional networking.
- Robert Gottlieb, Mark Vallianatos, Regina M. Freer and Peter Dreier (2005) examine a brand of “new progressivism” that has gained some momentum in Los Angeles, California. Their study highlights challenges being pursued in “Progressive L.A” by a new kind of labor movement, community-oriented environmentalism, and multiethnic coalition politics. Their book on this subject includes an appendix (based on the work of L.A.’s progressive social movements) that outlines a detailed agenda for action. Some of the major challenges are defined in terms of attaining affordable housing, a cleaner/healthier environment, improved mobility, smart growth, increased food quality/security through urban agriculture, civic engagement in government affairs, workers rights and a living wage (Gottlieb, Vallianatos, Freer, and Dreier 2005).

United Nations: (e.g., World urban forum, WEHAB, Sustainable cities, MDGs)

(Annan 2000; Annan 2002; Speth and Haas 2006; UN-HABITAT 2006a; UN-HABITAT 2006b; United Nations Human Settlements Programme. 2006; United Nations Human Settlements Programme. 2009) (Carpenter, DeFries, Dietz, Mooney, Polasky, Reid, and Scholes 2006)

The research community needs to develop analytical tools for projecting future trends and evaluating the success of interventions as well as indicators to monitor biological, physical, and social changes. (p. 257)

International Commissions/Organizations (e.g., Bruntland, EU, Civil Society)

(Robinson and International Union for Conservation of Nature and Natural Resources. Commission on Environmental Law. 1993; Speth and Haas 2006; World Commission on Environment and Development. 1987)

University-based research centers/initiatives, public intellectuals

21st century university goals (Baker 2003; Boggs 1993; Jones, McCarney, and Skolnik 2005)

Academic freedom (Doumani 2006)

Scientific organizations

NSF (Interagency Working Group on Information Technology Research and Development 2006)

World's Scientific Academies (Beck 2010; Committee on a New Biology for the 21st Century: Ensuring the United States Leads the Coming Biology Revolution; National Research Council 2009; International Council for Science 2010; Omenn 2006; Statement of the World's Scientific Academies 1996; Whiteman 2007; World's Scientific Academies 2000)

See: Special Issue of *Science* focused on Cities, February 8, 2008 (Ash, Jasny, Roberts, Stone, and Sugden 2008)

From BECK (2010: xxi) Challenge # 11: The Long View: Towards Sustainability of the Built Environment

Since the greatest debate of our times is the “sustainability debate”, with its significant implications for the design and operation of the built infrastructure at the interface between Man and Environment (most conspicuously so at the urban centers of socio-economic activity), how best should the [National Science Foundation’s] Environmental Observatories be deployed and, more specifically, what kinds of models should be developed in order to promote a better strategic alignment of the study of urban metabolism with that of ecosystem services, all within the web of global biogeochemical cycles? How too, in the widest of possible terms, can innovations in information and communication technologies (ICT) — as realized in the environmental cyber-infrastructure — lead to tangible gains in reducing the unsustainability of current patterns of socio-economic behavior?

International Council for Science. 2010. *Grand Challenges in Global Sustainability Research: A Systems Approach to Research Priorities for the Decade*. Paris: International Council for Science.

Abstract: The International Council for Science (ICSU) proposes to mobilize the international global change scientific community around an unprecedented decade of research, with the focus and intensity of a global ‘Apollo Project’, to address five Grand Challenges in Global Sustainability Research. In doing so it seeks to work in close collaboration with the International Social Science Council (ISSC) and other partners. Given the pace and magnitude of human-induced global change, immediate actions are needed to avoid dangerous outcomes for people and for the planet. In this context, science needs to deliver useful and reliable information that will directly and effectively inform and support the responses and actions of decision-makers and citizens in all regions of the world. This report is the product of an international consultative process led by ICSU and its partners that was designed to: (a) identify broadly-accepted grand challenges in global sustainability research; (b) identify high priority research that must be carried out to address those challenges; and (c) mobilize scholars in the sciences (social, natural, health and engineering) and humanities to pursue that research.

Global sustainability research builds upon and integrates expertise within the sciences (social, natural, health, and engineering) and humanities and applies it to pressing coupled social-environmental research questions of human interactions with the Earth system. (...) There is a need for transitions from:

- *Research dominated by the natural sciences to research involving the full range of sciences and humanities.* Social sciences have long been a component of Earth system research, but tackling the grand challenges described here requires a stronger

involvement and greater integration of the social sciences, health sciences, engineering and humanities, along with the natural sciences. It is increasingly clear that pathways to address rapid global change can only be found through inquiries that integrate the full range of sciences and humanities in ways that may lead to significant transformations in these disciplines as they are currently understood. It also requires the inclusion of local, traditional and indigenous knowledge.

- *Disciplinary research to disciplinary, interdisciplinary and transdisciplinary research.* Many of the priority research questions can only be solved through effective interdisciplinary research. Moreover, it is clear that both research progress and the effective use of scientific results by society and decision-makers can often be enhanced through transdisciplinary research; that is, through greater involvement of external stakeholders in the research process. Research will often be most useful, and the results most readily accepted by users, if priorities are shaped with the active involvement of potential users of research results and if the research is carried out in the context of a bi-directional flow of information between scientists and users. An effective response to global environmental change will be aided by the co-creation of new knowledge with a broad range of stakeholders through participatory practices. Source: International Council for Science. 2010: 6.

Sustainability Science

Knowledge systems: (Biermann 2002; Carpenter, Mooney, Agard, Capistrano, DeFries, Díaz, Dietz, Duraiappah, Oteng-Yeboah, Pereira, Perrings, Reid, Sarukhan, Scholes, and Whyte 2009; Cash, Clark, Alcock, Dickson, Eckley, Guston, Jager, and Mitchell 2003; Clark 2003a; Clark 2003b; Crow 2010; Kates, Clark, Corell, Hall, Jaeger, Lowe, McCarthy, Schellnhuber, Bolin, Dickson, Faucheux, Gallopin, Grubler, Huntley, Jager, Jodha, Kaspersen, Mabogunje, Matson, Mooney, Moore Iii, O’Riordan, and Svedlin 2001; Reid, Berkes, Wilbanks, and Capistrano 2006)

Science, technology and public policy: (Jasanoff 2004; Jasanoff 2005; Jasanoff 2010; Modvar and Gallopín 2004; National Research Council 1999; Omenn 2006)

Civic science: (Bäckstrand 2003; Corburn 2005; Sonnert and Holton 2002)

Making science matter (Bevington and Dixon 2004; deLeon 2003; Flyvbjerg 2001; Isserman 2000; Latour 2004)

Earth observation/ Climate Change (Hart and Martinez 2006; Jasanoff 2010; Kotchen and Young 2007; Miller Balstad 2002; Reid, Chen, Goldfarb, Hackmann, Lee, Mokhele, Ostrom, Raivio, Rockstrom, Schellnhuber, and Whyte 2010; Rodin 2008; Schellnhuber, Crutzen, Clark, Claussen, and Held 2004; Zeng, Ding, Pan, Wang, and Gregg 2008)

Urban Ecology: (Grimm, Faeth, Golubiewski, Redman, Wu, Bai, and Briggs 2008)

Landscape Sustainability: (Musacchio 2009a; Musacchio 2009b)

Clark, William C. 2007. "Sustainability Science: A room of its own." PNAS 104:1737-1738.

ABSTRACT: Sustainability science has emerged over the last two decades as a vibrant field of research and innovation. Today, the field has developed a core research agenda, an increasing flow of results, and a growing number of universities committed to teaching its methods and findings. Like “agricultural science” and “health science,” sustainability science is a field defined by the problems it addresses rather than by the disciplines it employs. In particular, the field seeks to facilitate what the National Research Council has called a “transition toward sustainability,” improving society’s capacity to use the earth in ways that simultaneously “meet the needs of a much larger but stabilizing human population, . . . sustain the life support systems of the planet, and . . . substantially reduce hunger and poverty” (1). 1. *National Research Council*

Policy Division Board on Sustainable Development (1999) Our Common Journey: A Transition Toward Sustainability (Nat'l Acad Press, Washington, DC).

ICT

Information society, cyberinfrastructure (Berman, Fox, and Hey 2003; Lynch 2008; Menou and Taylor 2006; Schön, Sanyal, and Mitchell 1999; Zimmerman and Horan 2004)

Community informatics (Gurstein 2000; Marshall, Taylor, and Yu 2004)

Disasters (Kershaw 2005)

Multimedia and story telling: (Bogost 2006; Bogost 2007)

In an article titled "Information Technology for Public Policy," Roberta Balstad Miller (1996: 8) notes: "(T)here is widespread recognition that understanding of the ways that human action affect global change is dependent upon the creation of merged, georeferenced, time.-series databases that contain both socioeconomic data and physical data that reflect the interaction of human and physical forces over time." The data sets available are piling up-- in government databases, digital libraries, data warehouses, company files, and research labs. However, as Miller and others point out, before policy analysts will be able to take full advantage of new information-rich technologies in environmental policy and assessment, a number of scientific and technical challenges must be addressed, including the need to:

- create merged data sets (i.e., data sets which encompass both socioeconomic and physical/biological data),
- develop both time- series databases and baseline data; and
- expand access and electronic capability in developing countries (Balstad Miller 1996)

Globalization, Justice

Globalization (O'Meara, Mehlinger, and Krain 2000)

Global civil society (Alexander 2006; Douglass and Friedmann 1998; Esty and Ivanova 2006; International Center for Sustainable Cities 2006)

Global Complexity (Urry 2003)

Global flows (Mol 2001; Spaargaren, Mol, and Buttel 2006)

Is capitalism sustainable, progressive globalization (Jacobs, Lent, and Watkins 2003; O'Connor 1994)

Federation of city-states: (Friedmann 2001; Parker 2004)

Environmental justice (Pellow 2007; Pellow and Brulle 2005)

Food Justice: (Gottlieb and Joshi 2010)

Geographic

Europe (Scott 2006)

Industry (corporate initiatives)

(National Research Council (U.S.) Committee on Grand Challenges for Sustainability in the Chemical Industry 2006) (Cohen 2005)

Integration

(Ravetz, Sustainable City-Region Working Group., Town and Country Planning Association (Great Britain)., and Robert 2000)

New Biology/ Nanotechnology

Biosociety, Global health, (Benyus 1997; Frenay 2006; Juma 2006; Persad, Quach, Thorsteinsdottir, Salamanca-Buentello, Singer, and Daar 2006; Varmus, Klausner, Zerhouni, Acharya, Daar, and Singer 2003)

Nanoscience and engineering (Nanoscale Science and Council 2004)

Committee on a New Biology for the 21st Century: Ensuring the United States Leads the Coming Biology Revolution; National Research Council. 2009. *A New Biology for the 21st Century: Ensuring the United States Leads the Coming Biology Revolution*. Washington, D.C.: The National Academies Press.

SUMMARY: Now more than ever, biology has the potential to contribute practical solutions to many of the major challenges confronting the United States and the world. A New Biology for the 21st Century recommends that a "New Biology" approach--one that depends on greater integration within biology, and closer collaboration with physical, computational, and earth scientists, mathematicians and engineers--be used to find solutions to four key societal needs: sustainable food production, ecosystem restoration, optimized biofuel production, and improvement in human health. The approach calls for a coordinated effort to leverage resources across the federal, private, and academic sectors to help meet challenges and improve the return on life science research in general. (Committee on a New Biology for the 21st Century: Ensuring the United States Leads the Coming Biology Revolution; National Research Council 2009)

Environment

Environmental justice (Pellow and Brulle 2005)

Web Sites

(Center for Global Metropolitan Studies 2006)

Social Sciences

Ruttan, V. W. (2003). Grand Challenges for the Social Sciences.

Abstract : In this paper I identify several "Grand Challenges" that confront human society as it makes the transition into the twenty-first century.¹ These include the issue of constitutional arrangements for multinational states; the reduction of poverty within and among states, achieving viable urban civilizations; the transition to global environmental sustainability; and the more general issue of institutional design.² If the social sciences are to demonstrate their social and economic value it is important that they contribute to the design of the institutions that will enable both the presently developed and the least developed societies to navigate the transitions posed by these challenges. Success in each of these endeavors will require fundamental advances in our understanding of institutional design.

Fromm, Erich. 2005. *To have or to be?* London ; New York: Continuum.

To have or to be? Is one the seminal books of the second half of the 20th century, it is Erich Fromm's manifesto for a new social and psychological revolution to save our threatened planet.

This list below comes from the last chapter (titled "Features of the New Society") in Fromm's book. Fromm prefaces the list saying: "The first requirement in the possible creation of the new society is to be aware of the almost insurmountable difficulties that such an attempt must face." It would have to:

- solve the problem of how to continue the industrial mode of production without total centralization, i.e., with ending up in fascism of the old-fashioned type or, more likely, technological fascism with a smiling face.
- combine overall planning with a high degree of decentralization, giving up the 'free-market economy,' that has become largely a fiction.
- give up the goal of unlimited growth for selective growth without running the risk of economic disaster
- create work conditions and a general spirit in which not material gain but other, psychic satisfactions are effective motivations.
- further scientific progress and, at the same time, prevent this progress from becoming a danger to the human race by its practical application
- create conditions under which people experience well-being and joy, not the satisfaction of the maximum-pleasure drive.
- give basic security to individuals without making them dependent on a bureaucracy to feed them.
- restore possibilities for "individual initiative" in living, rather than in business (where it hardly exists any more anyway). (Fromm 2005)

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