Information Infrastructure to address Societal Grand Challenges

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Four Horsemen of the Apocalypse

War

Famine

Pestilence

Death riding on the Wild Beasts of the Earth

The Wild Beasts of Climate Change

Climate changes are long-term shifts in atmospheric and oceanic temperatures and in related weather patterns

The findings of climate science

There is "incontrovertible" evidence for the "unequivocal" conclusion that the cause of current climate changes is man-made

The primary cause is the burning of fossil fuels beginning with the deployment of the steam-engine in 1750s

The findings of climate science

Highest levels of greenhouse gases in 800,000 years

Temperature increases in last 50 years were greater than those in last 2000 years

Sea levels rose in the 20th century more than they have in the last 30 centuries

The drought in the western US was more severe and long-lasting than any other in 1200 years

The findings of climate science

Given these findings, 15,000 scientists have declared that we are facing, not an urgent problem, but a "climate emergency"

There is huge frustration among scientists at inaction

- They feel that they are "screaming into the void"
- Some have threatened to halt all further scientific work until there is action

The Frustration of Climate Scientists

"What's the use of having developed a science well enough to make predictions, if in the end all we're willing to do is stand around and wait for them to come true?"

The Frustration of Climate Scientists

"If you said, 'Let's design a problem that human institutions can't deal with,' you couldn't find one better than global warming."

So, what is to be done?

Recent Studies

Ithaka S+R has mastered an approach to identify and document research university organizational strategies

Among top university priorities: Address issues of broad public concern and do so by investing in STEM

The S+R reports also ask: are library strategies aligned with these university priorities?

Will STEM save us from the apocalypse(s)?

For War:	Armaments and surveillance
For Famine:	Genetic engineering
For Pestilence:	Vaccines
For the Wild Beasts:	Lower greenhouse gas emissions

There is just one problem

STEM research is necessary but demonstrably insufficient to fully address the problems represented by the Four Horsemen

Pestilence: COVID-19

There was a massive STEM effort to develop vaccines

But there were huge differential outcomes, especially for marginalized groups, both before and after the vaccines became available

Climate Change

Climate scientists have produced amazing findings

But frustration persists

Why?

For these broad societal grand challenges, research universities need to make a special kind of investment

And they need to tune their information support structures accordingly

Sources of frustration for climate scientists

We know reliably that disasters will occur but are still uncertain about when and where

These "predictable surprises" are driving researchers to understand climate dynamics at local levels

However, the persistent level of uncertainty leads the public generally to resist investing in remedies

Sources of frustration for climate scientists

Uncertainties also feed:

Active opposition that seeks to raise doubts about, and even deny, the existence of climate change

As well as "disinformation" campaigns, such as "Climategate"

Moreover, the push for local research requires special skills to engage local communities and allay suspicions

Pandemics and Climate Change are "Wicked Problems"

Those frustrations are characteristic of "wickedness:"

Detailed STEM research is not enough

A psychological disposition to avoid uncertainty

Economic calculations about perceived risk

The politics and culture of resistance

Pandemics and Climate Change are "Wicked Problems"

"Wickedness" is a concept from complexity studies

Not "wicked" as in "evil"

Not "wicked in the Bostonian sense of "she is 'wicked' (or very) smart"

But also not complex like a "moonshot," where there is a clear measure of success: either you land on the moon or you don't

Pandemics and Climate Change are "Wicked Problems"

A problem is "wicked" when it:

Is hard to define – "vicious" like a circle

Lacks clear solutions – "tricky" like a leprechaun

Climate Change is a "Wicked Problem"

Components of the problem and solution are interlocking physical, biochemical, political, legal, economic, psychological, cultural, and other systems

The problem may be defined in terms of oceanic and atmospheric variables

But takes a different shape if viewed from the perspective of social and cultural systems

Normal science is inadequate

For wicked problems, a different kind of science is needed

Sometimes called “post-normal” science or “mode 2” knowledge production, it requires interdisciplinary research that includes expertise from:

- STEM, social science, and humanities disciplines
- Affected communities outside of academia

Normal science is inadequate

A workshop in 2016 on "University-led Grand Challenges" attracted 20 universities

It called for a "paradigm shift" to support wicked problem research

It recommended leveraging centers and institutes as places for interdisciplinary and community-engaged research

Examples show this approach at work

I interviewed researchers affiliated with climate change research centers and institutes

Plus administrators and librarians and other information specialists

A total of 44 individuals at 12 R1 or R2 universities

Sociologist

With a data specialist:

Identify and map the location over time of chemical waste left by industry as well as small businesses such as gas stations and car repair shops

Document changes in land use and trace the cultural, political, and economic efforts that led to mitigating and, in many cases, concealing the hazards

Engineer and Urban Planner

In partnership with the state office of Climate and Energy and with zoning officers in dozens of local communities:

Collect and analyze zoning ordinances from websites to determine how local communities regulate the deployment of solar and wind power

Historian

In collaboration with a data scientist and community data sources:

Gather scientific documentation of weather events, local community disaster declarations, and insurance data

Evaluate locations across the country as possible "climate havens"

Sustainable Systems Engineer

As part of a team including an aerospace engineer and air traffic controllers:

Redesign landing, takeoff, and taxiing routes to conserve fuel

Conservation Ecologist

Working with various stakeholders, including indigenous communities, in coastal North Carolina:

Identify local values and perspectives

Integrate them into tools for locals to make decisions about whether and how to preserve cultural monuments endangered by weather events and rising sea levels

Political Scientist

In collaboration with an ecologist and local indigenous communities in artic regions:

Co-develop research strategies to understand local climate changes and possible mitigation and adaptation strategies

Law Professor

In partnerships in various cities with local community stakeholders and university researchers:

Create laboratories for governing the city as a commons

Focus participants in the lab on how to address climate change and environmental justice

If the university's priority is to support research like this on "wicked problems," then how do librarians and other information specialists align their strategies to this priority?

Four suggested adjustments:

Focus on research in university-supported centers and institutes devoted to wicked problem research

Foster skills needed for interdisciplinary research

Support local communities in defining and co-producing research

Enhance data support to accommodate the nature and scale of interdisciplinary and public contributions

Information infrastructure: Centers/Institutes

Libraries have generally relied on a liaison model for research support

The liaison role is based on the traditional subject librarian, but there has been much experimentation

- Subject vs. functional digital expertise
- The "informationist" in medical librarianship

Information infrastructure: Centers/Institutes

Despite the experimentation, liaisons mainly interact with departments—and for good reasons:

Departments are the "essential and irreplaceable building blocks" of the university

They provide the disciplinary home for faculty; manage appointments, tenure and promotions, and course assignments; and confer degrees

Information infrastructure: Centers/Institutes

- Centers and institutes complement departments and serve as research units
- However, they are relatively easy to create, hard to eliminate, and there is often a dizzying array of them
  - Many are simply the labs of individual faculty
  - Others are for specific projects and created at the behest of a funder or industry sponsor

Information infrastructure: Centers/Institutes

Universities recognize the value of these various kinds of centers and institutes, but do give special attention to others, such as those devoted to climate change

For librarians and IT specialists to allocate liaisons and other research support to these specialized centers and institutes, what distinguishing criteria should they look for?

Information infrastructure: Centers/Institutes

The key distinguishing criteria include:

- A director reporting to the provost or VPR
- A formal mission and strategic plan for wicked problem research
- A stable budget for staff and seed funding
- A schedule for regular convenings to share work
- Faculty participation from a variety of disciplines

Information infrastructure: Interdisciplinarity

Knowledge often advances when researchers work together at or across the edges of their areas of their expertise

Centers and institutes that address wicked problems must foster work across disciplinary boundaries

Information infrastructure: Interdisciplinarity

Historians and philosophers of science have identified various kinds of work across disciplinary boundaries, but these are the main types:

Multidisciplinarity

Interdisciplinarity

Transdisciplinarity

Information infrastructure: Interdisciplinarity

The key factor is the level of integration

- Multidisciplinarity: coordinate research by juxtaposing data, methods, and concepts
- Interdisciplinarity: integrate data, tools, and concepts to achieve results
- Transdisciplinarity: merge approaches to achieve new concepts and methods

Information infrastructure: Interdisciplinarity

The level of integration depends, at least in part, on the intellectual proximity of the fields

The closer the fields, the greater the chance of transdisciplinary breakthroughs (e.g. biochemistry)

Information infrastructure: Interdisciplinarity

Although funders regularly push for transdisciplinarity, doing so for wicked problem research may be counterproductive

Exposure to distant fields may be more informative

Caution is needed to avoid the "disciplinary capture" of values, concepts, or methods by researchers in one field over those in other, often poorly funded, fields

Information infrastructure: Interdisciplinarity

There are two key information support requirements for research across disciplinary boundaries:

- Conceptual translation: metadata specialists can help create lingua francas, but may need to reimagine or repair existing metadata structures
- Methodological integration in key functional domains: textual, audiovisual, spatial, and numerical

Information infrastructure: Engagement

University missions: research, teaching, and **service**

Service is different from scholarly engagement, which:

- Recognizes the value of different, usually practical or indigenous, modes of knowledge
- Treats the communities bearing this knowledge, not as objects of study, but as participants who help determine what to study and how

Information infrastructure: Engagement

Types of relevant communities include:

- Local residents with deep understanding of local climate changes and their effects
- Owners/custodians of endangered cultural heritage
- Industry partners responsible for controlling emissions
- Underrepresented communities downwind, downstream or otherwise harmed by climate changes

Information infrastructure: Engagement

Examples mentioned earlier:

Air traffic controllers,

Custodians of coastal cultural heritage,

Indigenous communities in the artic;

Residents of urban neighborhoods

Information infrastructure: Engagement

Information requirements for engaging these communities are similar to those for interdisciplinarity: conceptual translation and methodological integration

However, value conflicts in conceptual definitions and methodological approaches may be more complicated and time-consuming to resolve

Information infrastructure: Engagement

To build trust, special efforts may be needed to make academic climate models more easily accessible

Care is also needed in the creation and management of community-generated knowledge

Big caution: funding requirements for engaging local communities can lead to carpetbagging, with PIs swooping in and ruining carefully built relationships

Information infrastructure: Data Support

Many climate scientists will continue to follow discipline-based models of research

They will avail themselves of the university, national and international infrastructures for big data science to build and refine their climate models

They will also rely on appropriate repositories to meet FAIR standards and data management requirements

Information infrastructure: Data Support

Researchers who participate in university-supported climate change centers and institutes raise an additional set of data support issues

There are the fundamental issues, already discussed, of translation, methodological integration, and value alignment associated with interdisciplinarity and community engagement

Information infrastructure: Data Support

In addition:

Climate change centers and institutes concentrate researchers across disciplines around a problem

This concentration provides an opportunity to avoid one-off support and to scale effforts to harden the local infrastructure of tools and methods for data gathering and analysis

Information infrastructure: Data Support

Research centers are generally unable to offer support for the research process

Researchers complained (to me) about reproducibility problems and almost uniformly called for professional help in data gathering and analysis

With concentration that a center provides, there is an opportunity for relatively efficient responses

Information infrastructure: Data Support

A problem-oriented concentration of researchers implies a shared interest in certain data types (text, numerical, spatial, AV) and methods for analysis

There is a corresponding opportunity here to concentrate professional expertise and build, test, and harden a shared infrastructure of tools and methods

The center also provides a platform for introducing new tech (AI, digital twins) in one place across fields

Conclusion

Librarians and IT specialists have gained many of the necessary skills for supporting climate change centers, interdisciplinarity, public engagement and data in their support for digital scholarship, public humanities, and data management

The recommendations here recognize resource limitations and call for relatively modest adjustments and extensions in these service strategies

Are these adjustments feasible?

Would they have desirable effects?

Thank You!

Questions and discussion?

Also: Join me at the Breakfast Discussion Table

Contact me by email: djw@40overbrook.com