The Critical Need for Evidenced-Based Analyses in Socio-STI Megatrends: Security, Populism, Fake News

NISTEP 30th Anniversary Symposium

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The World of 1988

My First NISTEP Computer

- The Cold War was still underway
- Japanese economy was the envy of the world
- Mobile phones had just started to enter the market
- Japan had not yet connected to the Internet
- The first Internet Worm infected the network, affecting 6,000 of 60,000 sites
- The Human Frontier Science Program was being established
- The Intergovernmental Panel on Climate Change (IPCC) was established
  - NASA Scientist Jim Hansen used the term Global Warming in Congressional testimony

あれから30年 –
STI and STI Analyzes have Evolved Greatly

Understanding expanded greatly in scale − global climate
Capability expanded greatly in precision − nanoscale
Capability expanded greatly in depth − genetics and disease
Reach of any individual is now global and instantaneous

Bringing

Accelerated global impact
Deeper changes to who we are and what we believe
Growing gaps in understanding and unease in society regarding the impact of STI
Greater ability for large-scale misuse

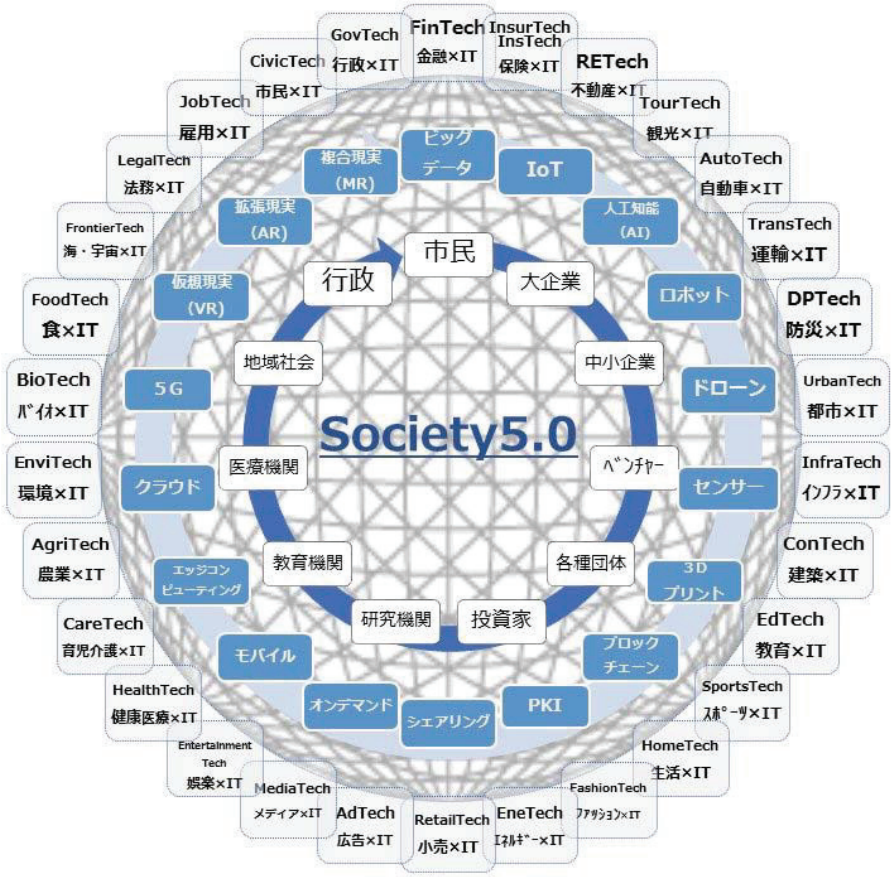
Therefore

STI policy research must reflect these changes and inform a much broader set of actors

Also an Increasingly Integrated Global STI Ecosystem – Inclusive Innovation to Circulating Innovation

- Uber to Ojek to Skateboards
- The challenge is how to better link to overseas innovation for synergistic organic growth

Evidenced-Based STI and MegaGoals



Socio-STI Megatrends:
Not just reshaping our tools, but reshaping ourselves

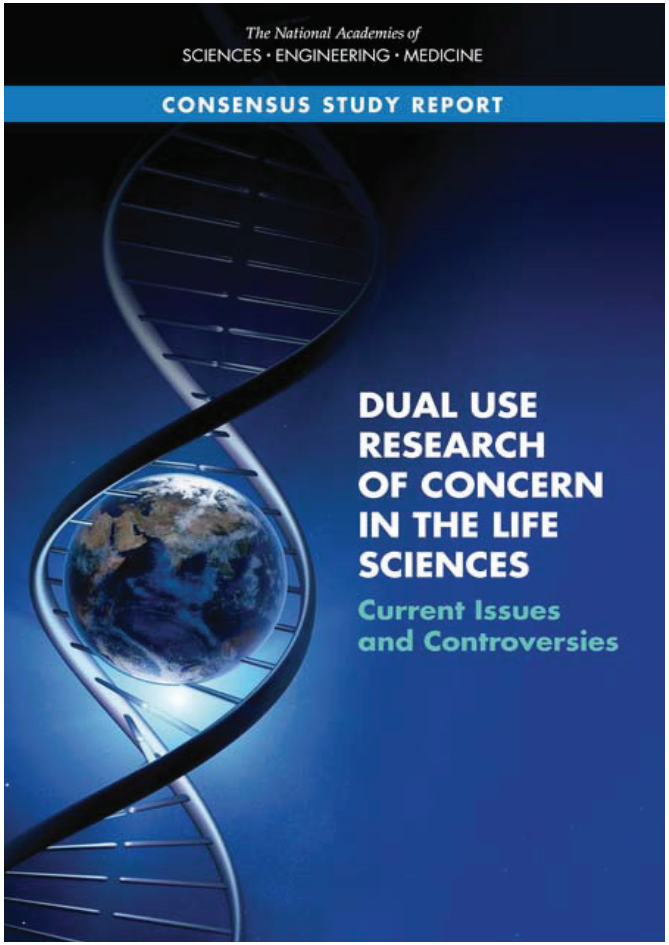
- STI is changing who we are, how we think, and how safe we are

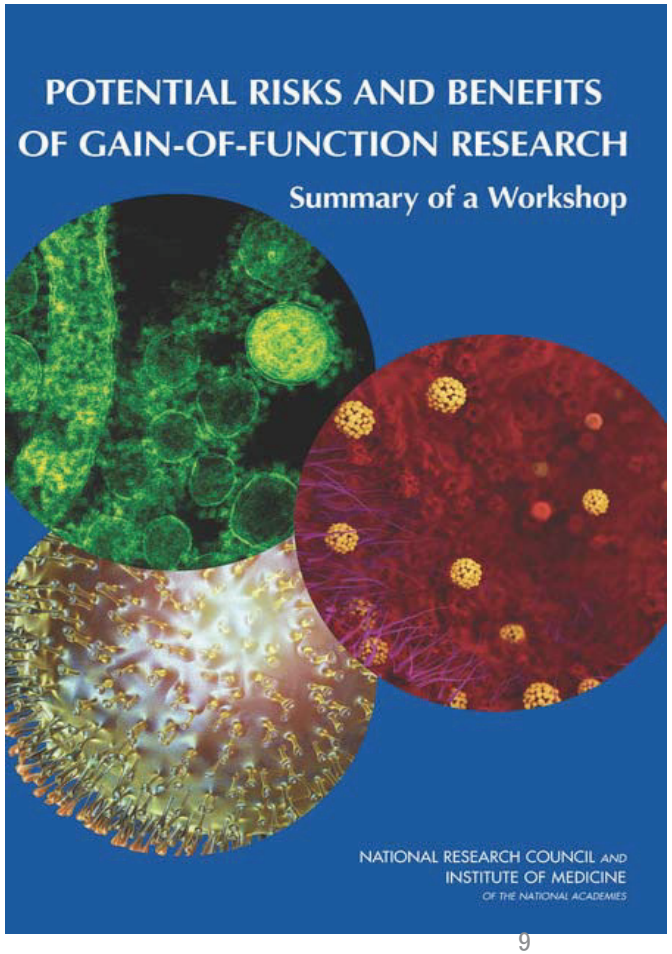
Need for Evidence-Based Analysis to Manage the Future - Selected Socio-STI Megatrends

- Shifting challenge to security −STI and security are inseparable
- Change in who we are − STI immediately poses societal, ethical and existential issues
- Rise of populism and information confusion − STI is no longer for the elite
- Therefore STI policy cannot only target elites but must be made relevant across society

Security – Changing Modality of the Threat

Dual-Use Increasingly Inherent in Science





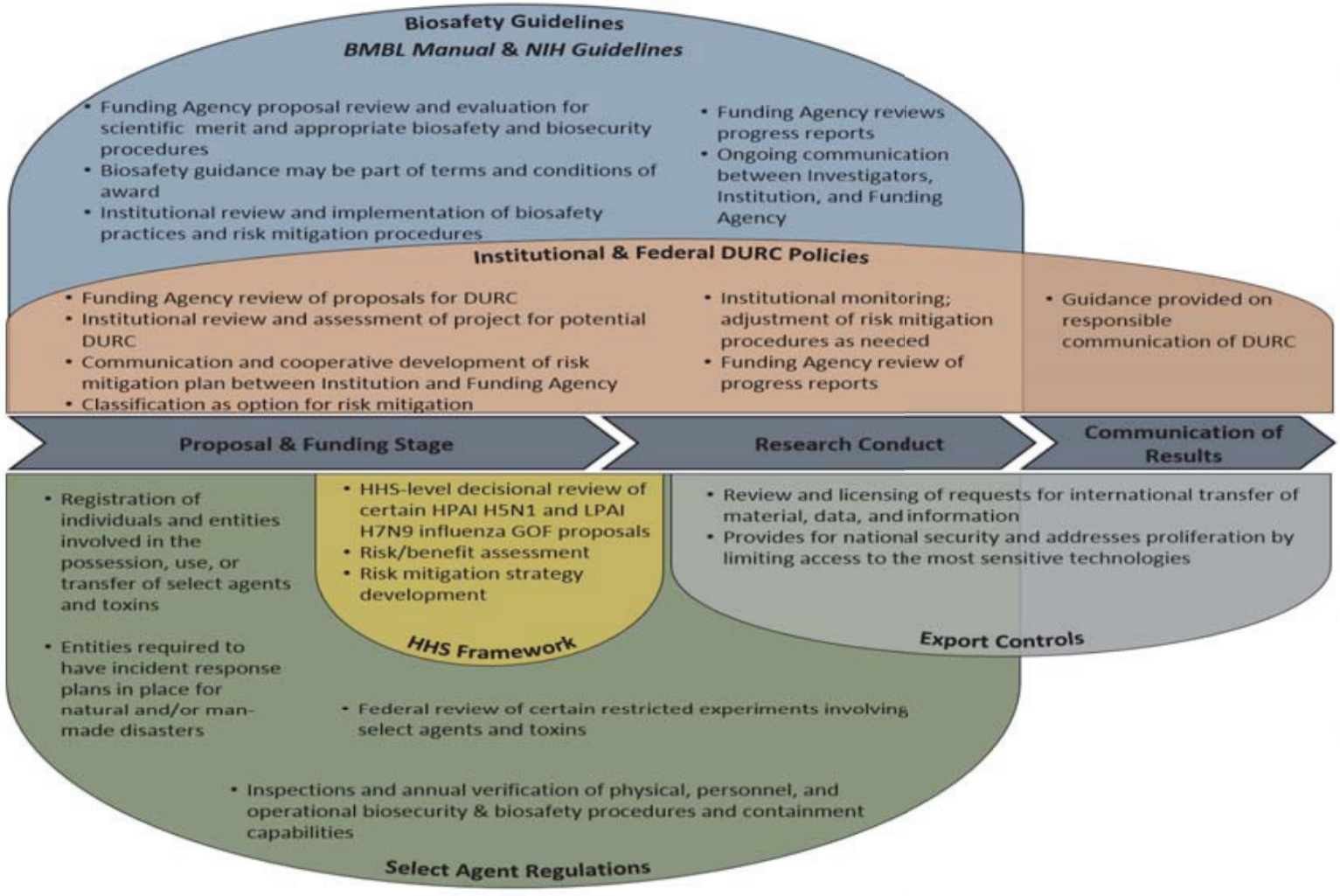
Example: Gain of Function Research Moratorium

- On October 17, 2014, the White House announced that U.S. government agencies will institute a pause in the funding of new "gain-of-function" research on influenza, SARS, and MERS viruses that could increase the pathogenicity or transmissibility to mammals.
- During this funding pause, relying on the National Science Advisory Board for Biosecurity (NSABB), the government developed a framework for addressing the risks and benefits of such studies to develop a new Federal policy regarding the funding of this research.

NSABB Recommendations for the Evaluation and Oversight of Proposed Gain-of-Function Research

- **Finding 1.** There are many types of GOF studies and not all of them have the same level of risks.
- **Finding 2.** There are several points where risks can be managed
- **Finding 3.** Current oversight is not sufficient for all GOF research of concern.
- **Finding 4.** An adaptive policy approach is desirable.
- **Finding 5.** There are life sciences research studies that should not be conducted. The scientific merit of a study is a central consideration during the review of proposed studies but other considerations, including legal, ethical, public health, and societal values are also important and need to be taken into account.
- **Finding 6.** Managing risks requires both federal and institutional oversight and a commitment by all stakeholders to safety and security.
- **Finding 7.** Funding and conducting GOF research of concern encompasses many issues that are international in nature.

Elaborate Oversight Scheme in the U.S. − But if Only in the U.S. it Cannot Succeed



BMBL – Federal guidance on biosafety and containment practices for life science research involving biological infectious agents or hazardous material

NIH Guidelines – Federal guidance for oversight of biosafety and containment for research involving recombinant or synthetic nucleic acid molecules

DURC Policies – Federal & Institutional oversight of biosecurity risks, particularly involving the misuse of research information, products, and technologies

Select Agent Regulations – Federal & Institutional oversight of biosecurity and biosafety risks associated with the use and transfer of high-consequence agents & toxins

HHS Framework – HHS department-level review and approval of proposed gain-of-function experiments involving HPAI H5N1 & LPAI H7N9

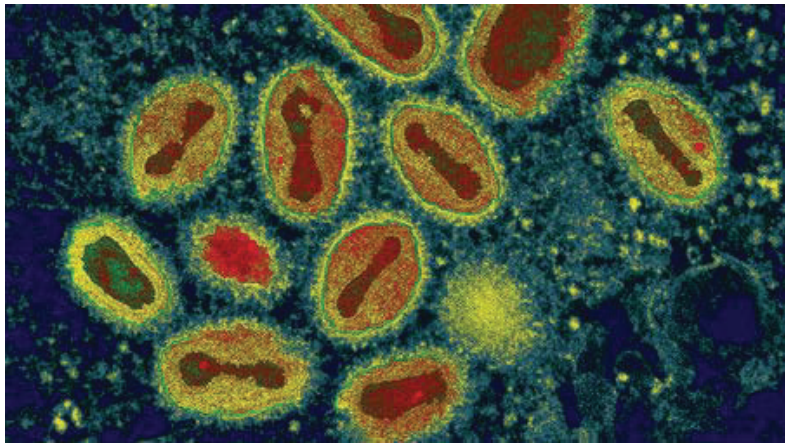
Export Controls – Federal oversight to limit access to, and international proliferation of, sensitive material and technologies

Step-by-step horsepox study stokes dual-use controversy

Filed Under: **Orthopoxvirus; Smallpox; Dual-Use Research**
Stephanie Soucheray | News Reporter | CIDRAP News | Jan 23, 2018

David Evans, PhD, professor of medical microbiology and immunology at the University of Alberta

- The study, titled, "Construction of an infectious horsepox virus vaccine from chemically synthesized DNA fragments," offers a step-by-step account of how they recreated the horsepox virus (HPX) using synthesized DNA fragments based on HPX and vaccinia virus genomes.
- This is the first time an orthopoxvirus has even been synthesized, which means there's now a new pathway for redeveloping the smallpox virus even though it's eradicated in nature
- The paper concludes with a warning: "Most viruses could be assembled nowadays using reverse genetics, and these methods have been combined with gene synthesis technologies to assemble poliovirus and other extinct pathogens like the 1918 influenza strain… our studies show that it is clearly accessible to current synthetic biology technology, with important implications for public health and biosecurity."



"We haven't described anything that isn't well-known in the field."

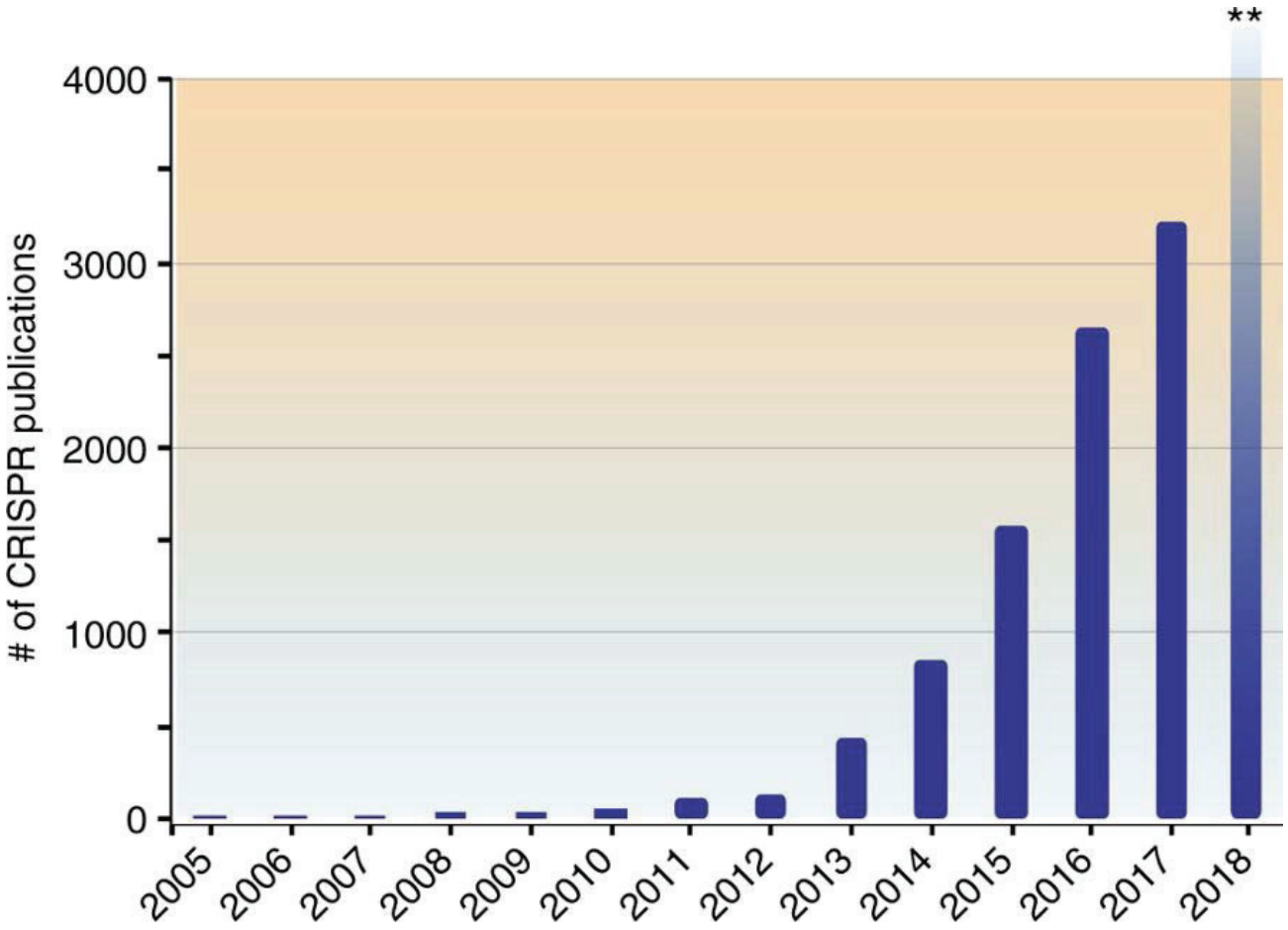
David Evans, PhD, professor of medical microbiology and immunology at the University of Alberta

The Nature of Science Will Not Allow Scientists to Avoid Security

Changing Ourselves

CRISPR-Cas9

- High impact
  - Immediate relevance to genetically based diseases
- Highly dispersed
  - Can be conducted with minimal laboratory equipment
- Highly active research
  - More than 3,000 journal papers in 2017
- Can manipulate any genetic trait, not just disease
- Ethical guidance and societal dialogue are essential



Numerous Experiments Underway Involving Animals

Inevitable that Experiments Involve Other Human Traits

Designer baby

Shutterstock

Human Testing

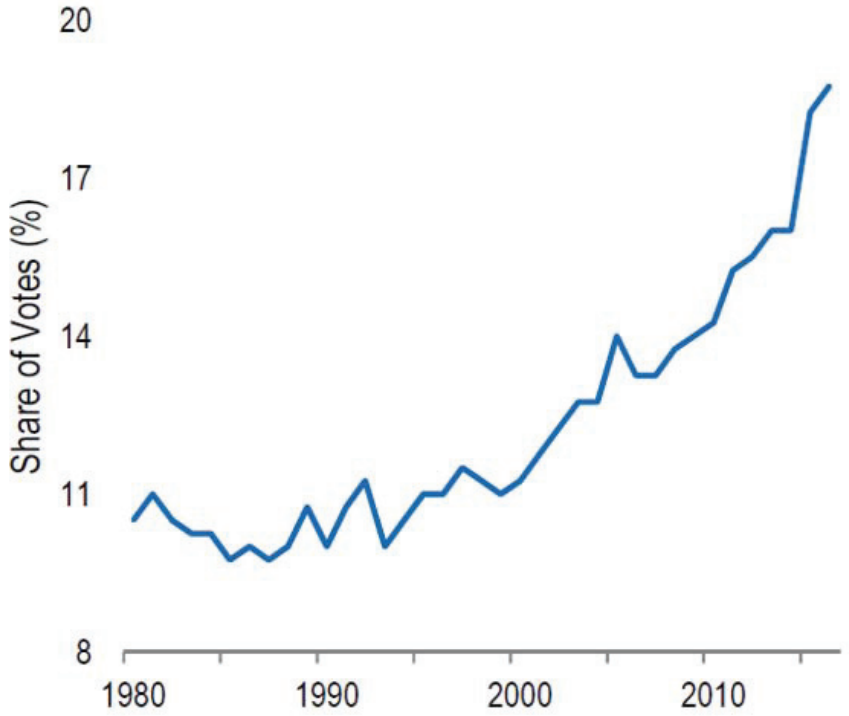
- In May 2015, in online journal, *Protein and Cell*, researchers led by Junjiu Huang, a gene-function researcher at Sun Yat-sen University in Guangzhou, attempted to modify the gene responsible for β-thalassaemia, a potentially fatal blood disorder, using CRISPR/Cas9.
  - The team used 'non-viable' embryos, which cannot result in a live birth, that were obtained from local fertility clinics.
- August 2018, Vertex Pharmaceuticals (US) and CRISPR Therapeutics (Switzerland) announced a joint US FDA approved trial of a CRISPR-Cas9 therapy for the β-thalassemia.

The Boat has Left the Dock

Populism

Figure 1: Support for Populist Parties Has Grown in Europe

Percentage of votes for populists, 1980-2016



Source: Timbro, Allianz Global Investors. Data as at 2016.

Populism on the Rise – Unease with Elites

- Suspicions of elites and of yielding power to foreign interests
- Cannot assume that support for STI will always be there

"America's policy of principled realism means we will not be held hostage to old dogmas, discredited ideologies, and so-called experts who have been proven wrong over the years, time and time again. This is true not only in matters of peace, but in matters of prosperity."

President Donald Trump, Speech to the UN General Assembly, September 25, 2018

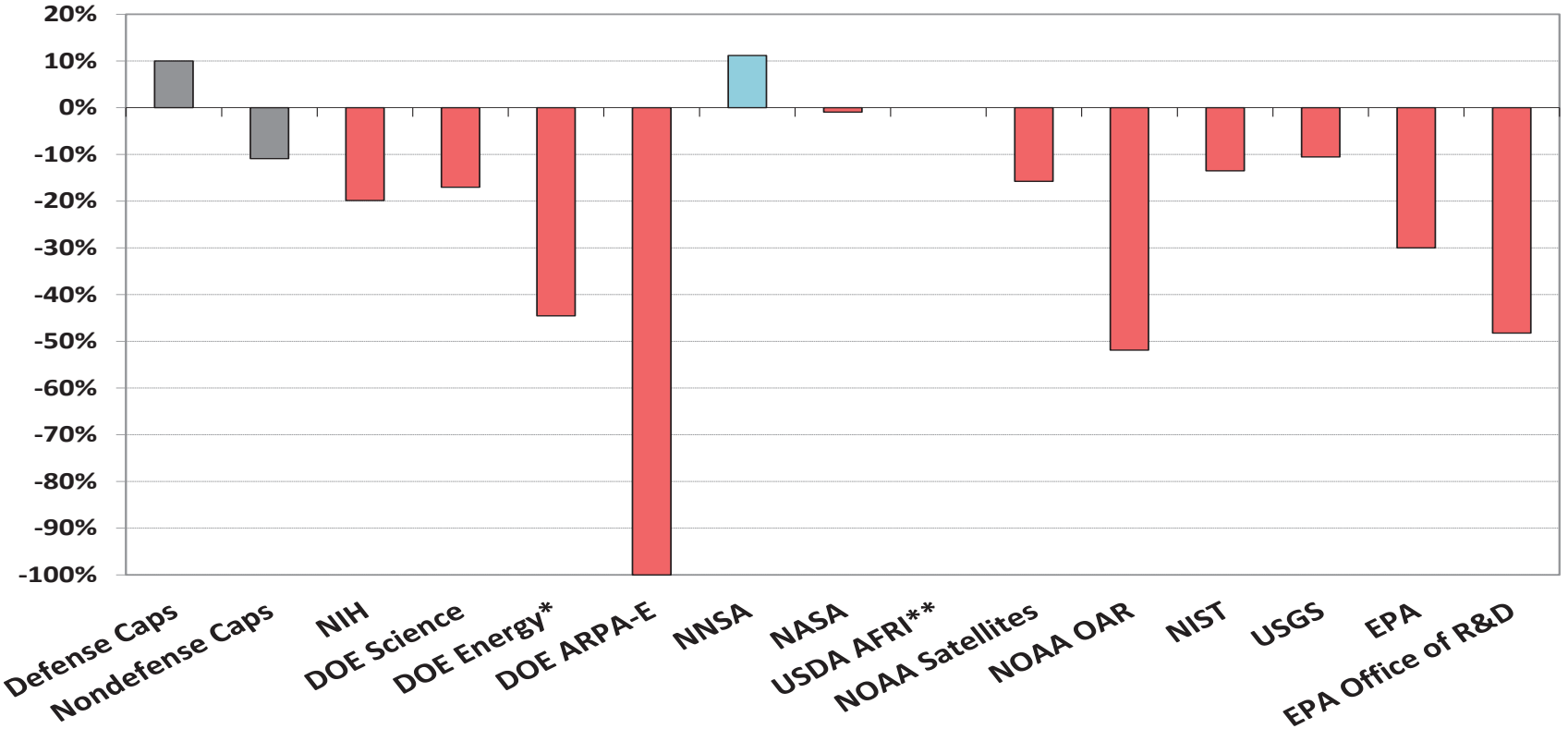
In a discussion about climate change, when President Trump was asked about scientists who say hurricanes and other extreme weather events are worsening, Mr. Trump replied,

"You'd have to show me the scientists because they have a very big political agenda."

CBS 60 Minutes, October 14, 2018

Science & Tech Agencies and Offices:
Preliminary Estimates of the FY 2018 Request vs. FY 2016

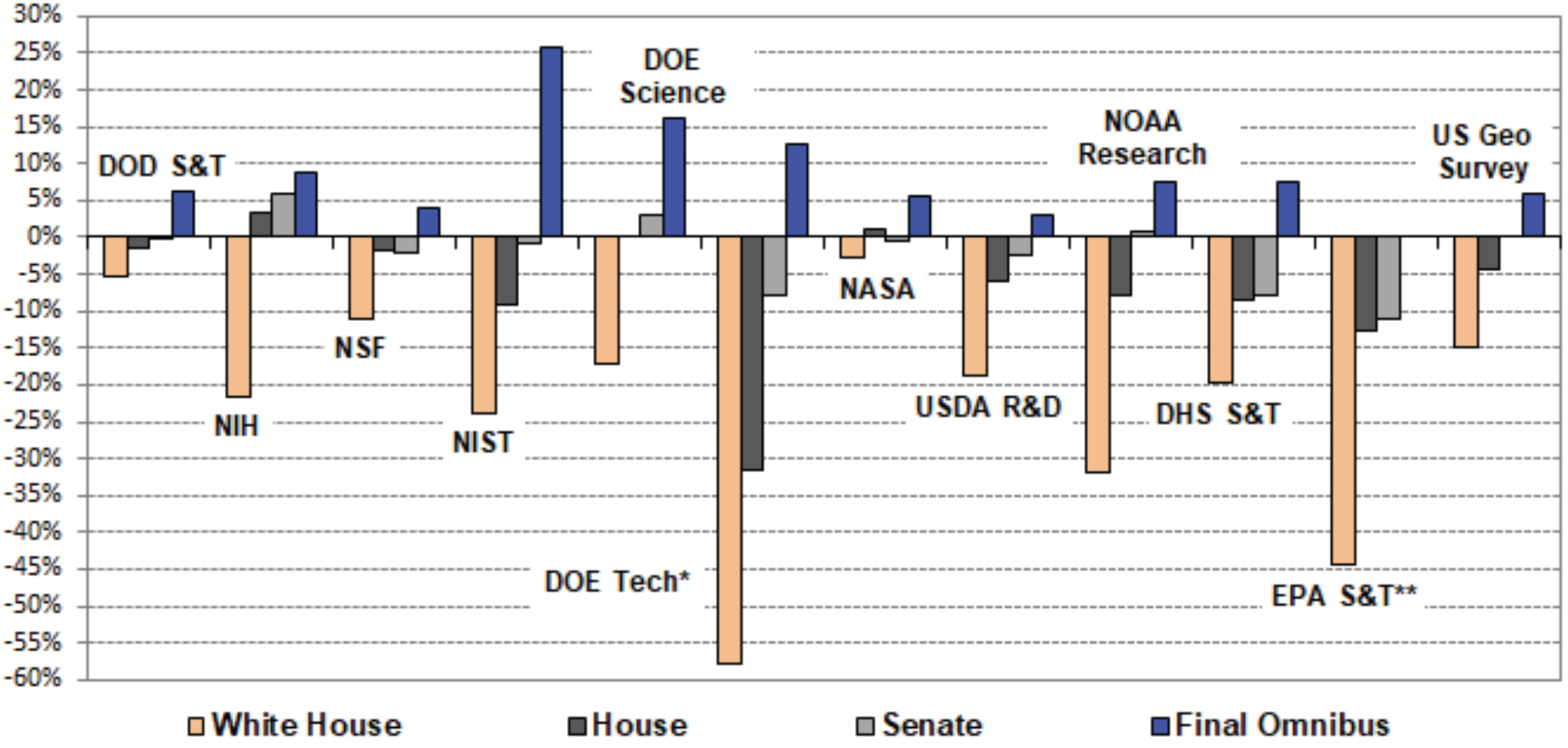
Estimated percentage change from FY 2016 levels, nominal dollars



*Includes renewables and efficiency, nuclear, fossil, grid research. **Flat-funded in FY18 request.
NOTE: FY 2016 is used as a baseline given lack of final FY 2017 appropriations.
Based on initial AAAS assessment of the FY 2018 budget summary and past agency budget data. March 16, 2017 | AAAS

Appropriations for Select Science & Tech Agencies

Percentage change from FY 2017 enacted levels, nominal dollars



*Includes renewables, efficiency, nuclear, fossil, grid, ARPA-E. **Flat in omnibus. | AAAS

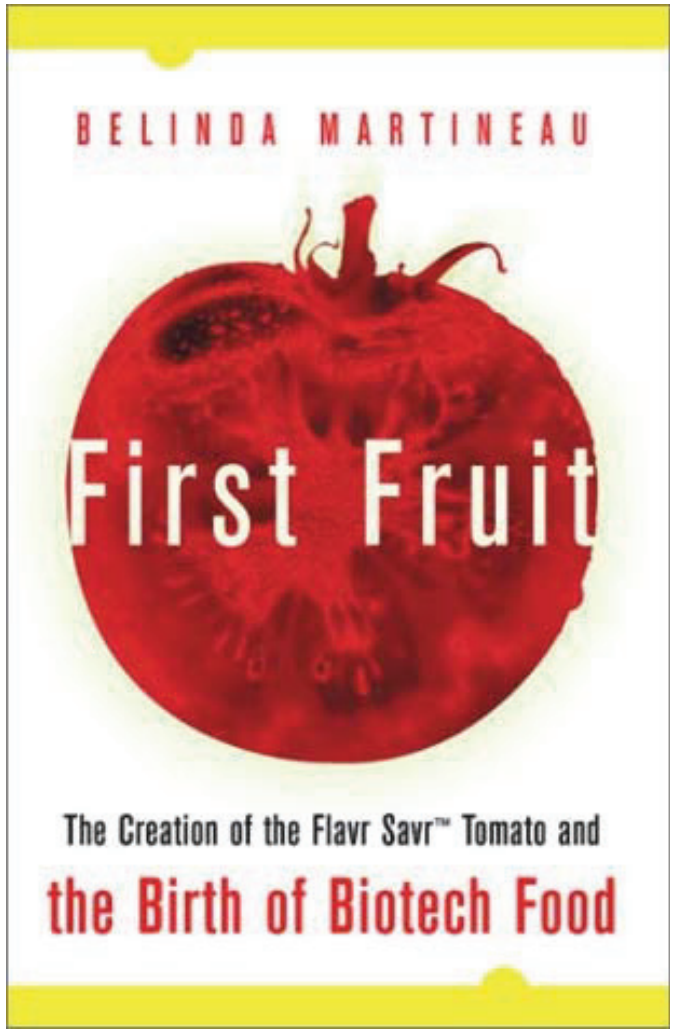
Voice of Scientists and Citizens

It is mankind's quest to understand the universe, to see light where there is only darkness. *Forbes Magazine Editorial*, April 22, 2017

GMOs

GMO Industry Launches

- In 1994, the FLAVR SAVR tomato, modified to delay premature fruit softening, began to be sold in U.S. grocery stores
- From 1996, insect resistant Bt maize and Bt cotton, as well as transgenic herbicide tolerant soybeans and oilseed rape were planted on rapidly increasing areas.



GMO Evolution Outside Europe

- In 2014, genetically modified (GM) crops were grown by 18 million farmers in 28 countries comprising 13% of the world's arable surface.
- Globally, 82% of the total crop area for soybeans, 68% for cotton, 30% for maize and 25% for oilseed rape were planted with GM varieties in 2014.
- About 70% to 90% of the globally produced GM cops are used as feed for food-producing animals.
- In the USA itself, with a high adoption of GM crops, more than 95% of food-producing animals consume GM feed. During the last decade alone, this corresponded to more than 100 billion animals.

Whereas in Europe Acceptance of GMO Agriculture has been Slow

- Events in 1996 that created a controversy about the character and safety of European food.
- The wave of protest responding to these events galvanized the emergence of a powerful European social movement opposed genetically-modified organisms (GMOs).
- By 1998, a de facto European moratorium against the planting or use of GMOs came into effect.
- In 2010 the European Food Safety Authority issued a review of a decade of research, 2001-2010: "The main conclusion to be drawn from the efforts of more than 130 research projects, covering a period of more than 25 years of research, and involving more than 500 independent research groups, is that biotechnology, and in particular GMOs, are not *per se* more risky than e.g. conventional plant breeding technologies."
- 2014. Less than 0.1% of the global acreage of GM crops is cultivated in Europe.
- In April 2015, the EU announced rules for the use of GMOs. But it allowed individual governments to opt out by October 2015.
  - The opt out: measures can be adopted "related to environmental or agricultural policy objectives, or other compelling grounds such as town and country planning, land use, socioeconomic impacts, coexistence and public policy"
- By October 3, 2015 more than half the 28 countries in the European Union, 19 member states decided to ban their farmers from growing genetically modified crops.
- In 2017, The EU Court of Justice ruled that Member States must not, on the sole basis of the precautionary principle, adopt national emergency measures prohibiting certain authorized genetically modified organisms.

Matter of Trust

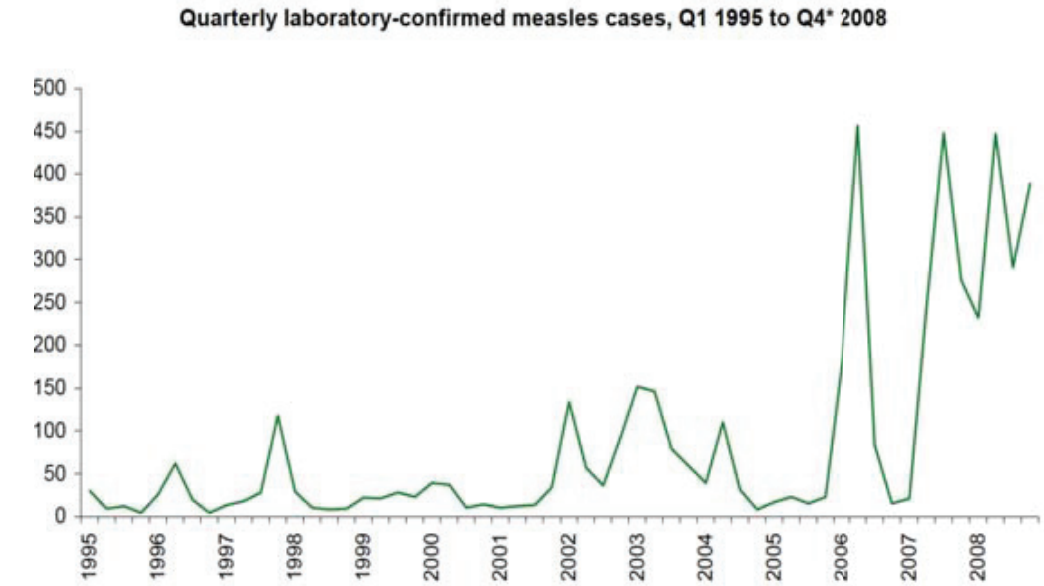
- In the 2001, Eurobarometer poll, nearly 71% of Europeans surveyed reported that “I do not want this kind of Food” and more than 56% believed that “GMO-based food is dangerous.”
- Eurobarometer opinion polls in 2003 that indicate that the European public trusts environmental and consumer groups over universities, government agencies, or industry to provide information about the hazards of biotechnology.
- 46% of the French were against GMOs in 1996 (before the food safety crises and the appearance of Novartis seed) whereas 65% were opposed in 1999 and 75% in 2002.

A World of Increasing Confusion Due to Misinformation

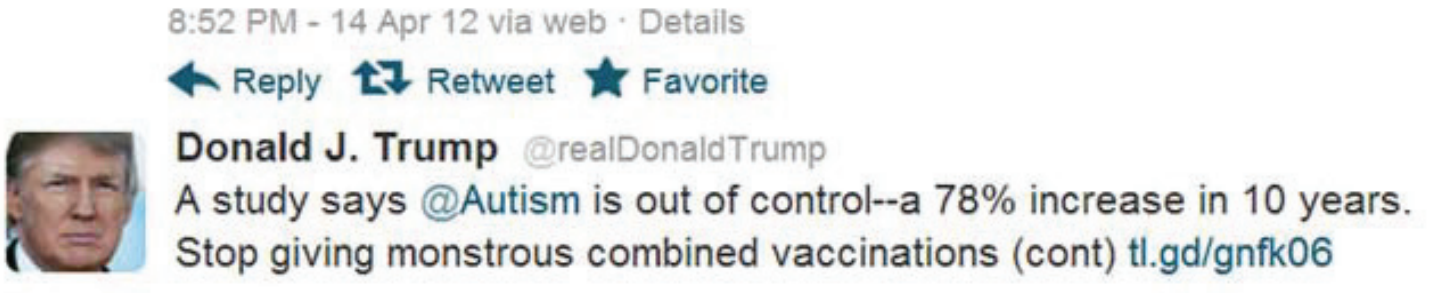
Perceived Reality
Science of Fake News -
Science for Policy

Measles Mumps Rubella (MMR) Vaccine and Autism

- In 1998, British Journal *Lancet* published an article by Andrew Wakefield linking the Measles, Mumps, Rubella (MMR) vaccine to autism.
- After the controversy the MMR vaccination compliance dropped sharply in the UK, from 92% in 1996 to 84% in 2002. In some parts of London, it was as low as 61% in 2003, far below the rate needed to avoid an epidemic of measles.
- After vaccination rates dropped, the incidence of two of the three diseases increased greatly in the UK.
- The study was discredited but the impact lingers on the Internet.

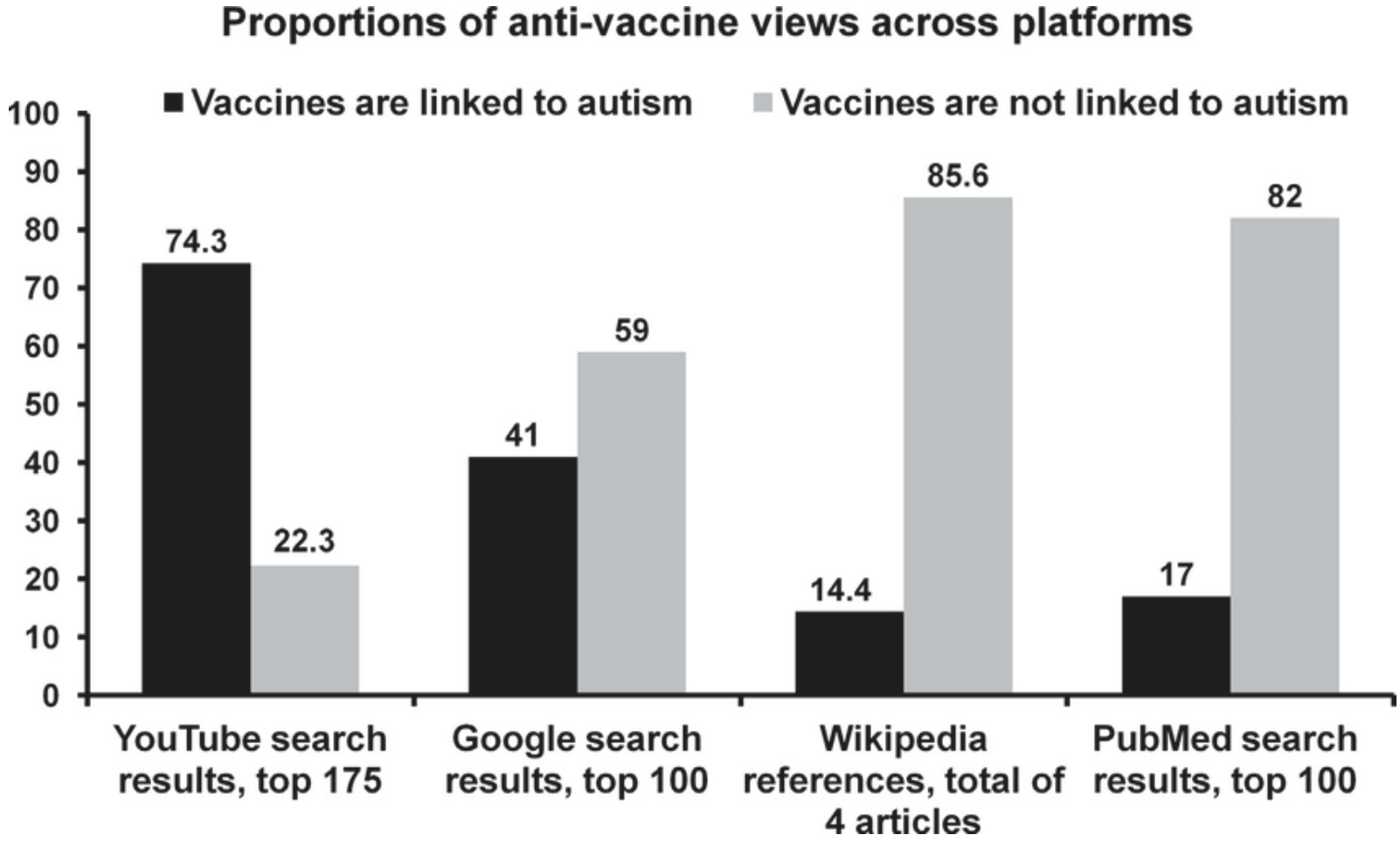


Spread of Misinformation



- Marine Le Pen who leads the French National Rally party, has championed the right of the people to say no in the face of a move by the government to make 11 vaccines mandatory for children.
- The founder of Italy's Five Star, Beppe Grillo, asserted that vaccines can be as dangerous as the diseases they protect against.
- There were 37 deaths from Measles in the first six months of 2018, when there were 38 in the whole of the previous year. Between January and June, 41,000 people in the region caught the disease. That's nearly double the number of cases in 2017. (*The Guardian*, August 22, 2018)
- In additional to "international scientific consensus" there must be greater "grassroots acceptance."

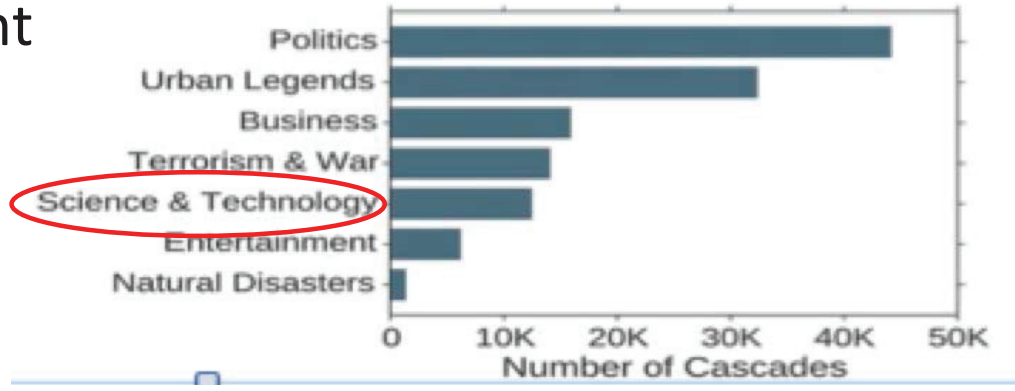
Incidence of False News by Information Source



Venkatraman A, Garg N, Kumar N. Greater freedom of speech on Web 2.0 correlates with dominance of views linking vaccines to autism. *Vaccine* (2015) 17(33):1422–5. doi:10.1016/j.vaccine.2015.01.078

Recent Study by Researchers at MIT Regarding Fake News

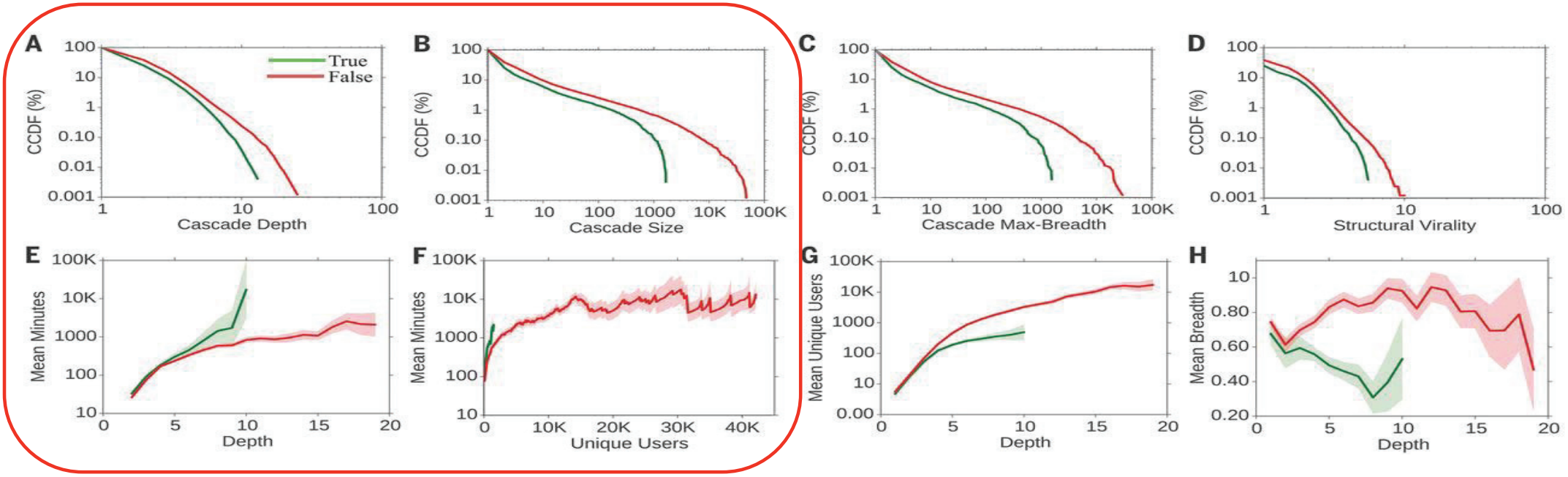
- The MIT researchers tracked roughly 126,000 cascades of news stories spreading on Twitter, which were cumulatively tweeted over 4.5 million times by about 3 million people, from the years 2006 to 2017.
- News was classified as true or false using information from six independent fact-checking organizations that exhibited 95 to 98% agreement on the classifications.



MIT Study (continued)

- False news reaches people 6 times faster true stories
- False news stories are 70 percent more likely to be re-tweeted than are true stories.
- When it comes to Twitter's "cascades," or unbroken re-tweet chains, falsehoods reach a cascade depth of 10 about 20 times faster than facts.
  - Falsehoods are re-tweeted by unique users more broadly than true statements at every depth of the cascade.

Fig. 2 Complementary cumulative distribution functions (CCDFs) of true and false rumor cascades.



Deeper Twitter Cascades. The authors found that accurate news wasn't able to chain together more than 10 retweets. Fake news could put together a retweet chain 19 links long—and do it 10 times as fast as accurate news put together its measly 10 retweets.

False news reached more people than the truth; the top 1% of false news cascades diffused to between 1000 and 100,000 people, whereas the truth rarely diffused to more than 1000 people.

Soroush Vosoughi et al. Science 2018;359:1146-1151

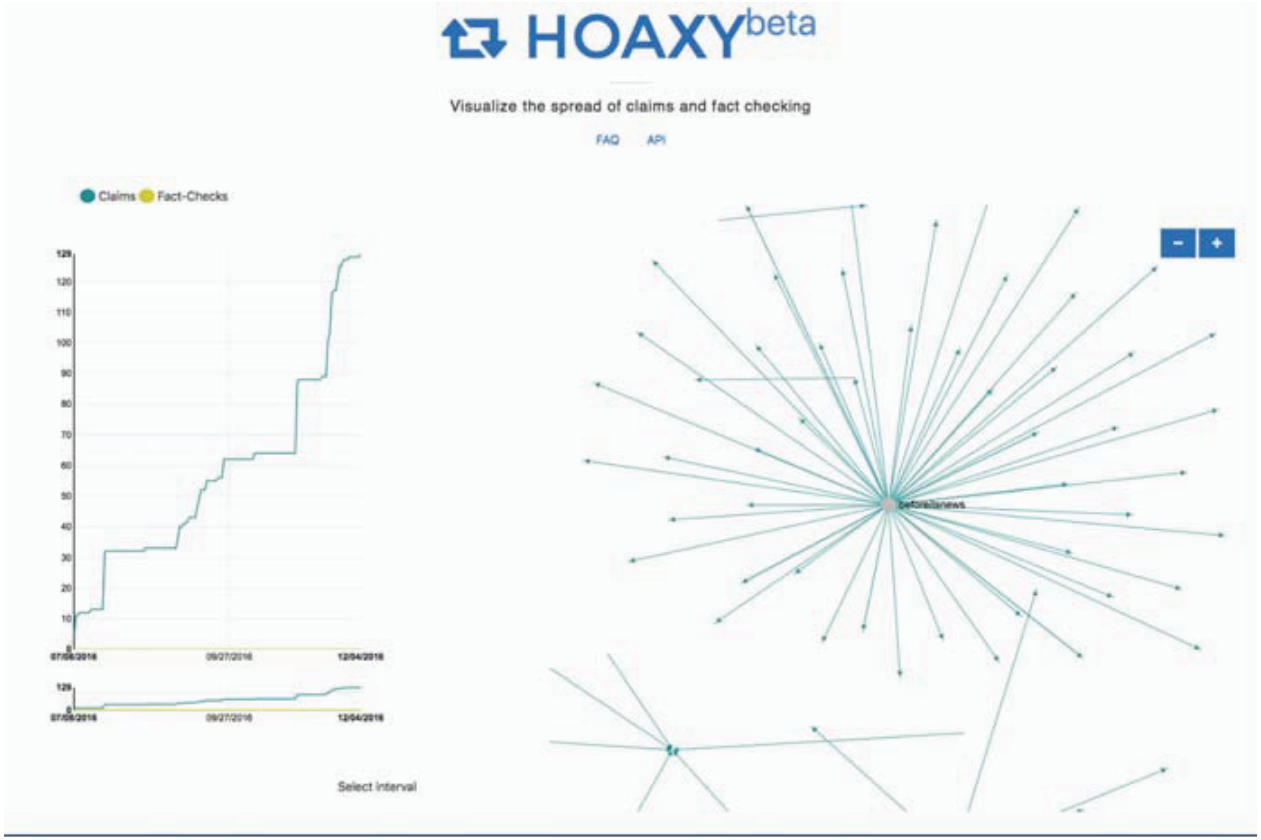
Published by AAAS

Fact Checking Site

- Snopes.com
- Factcheck.com
- Politifact.com
- hoax-slayer.com,
- truthorfiction.com,
- urbanlegends.about.com
- **In MIT study, the judgments overlapped 95 percent of the time.**

University of Indiana Observatory on Social Media

- Hoaxy - Visualizes how claims in the news – and fact checks of those claims – spread online.
- BotOrNot – System to assess whether the intelligence behind a twitter account is more likely a person or a computer.
- Tools – to allow anyone to analyze the spread of hashtags across social networks.



Growing Basket of AI Capabilities

- Face2Face − Manipulating expressions


Extensive Work Ahead

Evidence-based Analysis Needed to Improve the Impact of Evidence-based Analysis

- Need to better anticipate impact on society
  - Avoid always looking backward at data
  - More comprehensive perspective of path of societal diffusion and impact.
- Need to advance with clarity
  - Impact and scenario analyses will be important to guide policy in rapidly advancing fields to ensure we do not end up in an undesirable state.
- Everyone must be involved because anyone can do it
  - Offering the analysis passively to policy makers is not enough. Effectively communicating analyses at the grassroots is essential because that is where decisions are made.
- Form is as important as substance
  - Understanding how people receive and perceive information is important to ensuring an effective policy dialogue and outcome.


Congratulations!