

A Prescription for
Making Medicines
Affordable

Safely Transporting
Domestic Supplies of Oil,
Ethanol, and Natural Gas

Keeping Up With
Computer Science
Enrollments

Major New
Initiatives at the
National Academies

THE NATIONAL ACADEMIES INFOCUS

Spring 2018

Earth Observations from Space

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*The National
Academies of*

SCIENCES
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Cover: The Moderate Resolution Imaging Spectroradiometer on NASA's Terra satellite captured this image of the frozen Northeast United States on Dec. 28, 2017. Brisk northwesterly winds created rows of "cloud streets" as cold air blew over Lake Ontario and the Atlantic Ocean. NASA Earth Observatory image by Jeff Schmaltz

Page 1: (top to bottom) ©iStock/igorr1; ©iStock/anouchka; the Moderate Resolution Imaging Spectroradiometer on the Terra satellite captured this image on Jan. 4, 2018, of a rapidly intensifying Nor'easter that slammed the East Coast of the United States during the first week of 2018, NASA Earth Observatory image by Joshua Stevens; ©iStock/Reptile8488

Page 2: (top to bottom) Transportation Research Board's 97th annual meeting, January 2018, photo by Event Photography of North America Corp.; refugees from Syria, Iraq, and other war-torn countries attempt to enter Croatia from Serbia on Sept. 17, 2015. ©iStock/djenkaphoto

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Page 18: Alaska pipeline, ©iStock/sarkophoto

Page 19: Detail of surface ocean current speed in the Gulf of Mexico and surrounding regions from a global 1-kilometer simulation produced with the Massachusetts Institute of Technology general

circulation model (MITgcm). This visualization shows the tremendous complexity and variability of the ocean, including surface signatures of geostrophic eddies, submesoscale eddies, and internal tides. Image by Christopher Henze, NASA/Ames

Page 21: Swirls of milky blue and green reveal the presence of massive numbers of phytoplankton in the South Atlantic Ocean near the Falkland Islands. On Dec. 28, 2017, the Visible Infrared Imaging Radiometer Suite on the Suomi National Polar-Orbiting Partnership satellite acquired the data for this natural-color image. NASA Earth Observatory image by Joshua Stevens

Pages 22&23: NASA Earth Observatory images by Joshua Stevens and Jesse Allen

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Page 41: (left) ©iStock/brunoat; (right) refugees waiting to cross the Serbo-Croatian border in October 2015, ©iStock/BalkansCat

THE NATIONAL ACADEMIES

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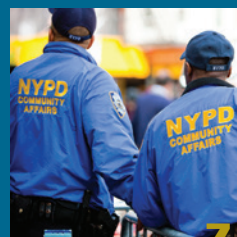
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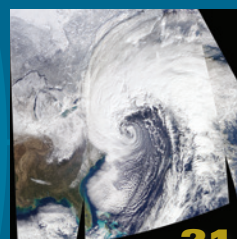
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A black car is shown in a severe state of disrepair, with its front end completely crushed and its hood open, revealing the engine. The car is surrounded by a large pile of broken wooden planks and debris on the road. In the background, a police car with flashing lights is visible, suggesting an emergency scene. The overall scene is one of a major traffic accident.

Alcohol-Impaired Driving

THE DEADLIEST
DANGER ON THE
ROAD TODAY



Alcohol-impaired driving remains the deadliest and costliest danger on U.S. roads today, and the resulting fatalities significantly exceed the number of deaths from distracted driving and drugged driving. On average since 1982, one-third of all traffic fatalities are due to alcohol-impaired driving — nearly 40 percent of whom are victims other than the impaired driver. Though progress to address this issue was seen in the 1980s to early 2000s, it has stagnated recently, and more than 10,000 alcohol-impaired driving fatalities still occur each year in the U.S. In 2010, the total economic cost of these crashes was \$121.5 billion.

Even though the causes of alcohol-impaired driving are complex and multifaceted, these deaths are entirely preventable, and many actions already proven to be effective as well as other promising strategies exist to deal with this persistent public health and safety problem,

says a new report from the National Academies of Sciences, Engineering, and Medicine. Stakeholders — from transportation systems to alcohol retailers to law enforcement — should work together to implement policies and systems to eliminate these deaths. Most strategies to reduce alcohol-impaired driving have focused on decreasing the likelihood that someone will drive after they are already impaired by alcohol through traditional enforcement and criminal justice approaches, but broadening the focus to also encompass reducing drinking to the point of impairment is critically important.

It can be difficult for individuals to understand how many alcoholic beverages it will take for them to become impaired, though. People differ in their degree of impairment due to several factors such as weight, age, sex, race, and ability to metabolize alcohol, the report says. In addition, inconsistent serving sizes and the combination of alcohol with caffeine

and energy drinks, among other factors, undermine individuals' ability to estimate their level of impairment.

In all 50 states, the blood alcohol concentration (BAC) limit proscribed by state laws for drivers age 21 or older is 0.08 percent, and even lower thresholds apply for drivers under age 21. The committee that wrote the report found that an individual's ability to

More than 10,000 alcohol-impaired driving fatalities still occur each year in the U.S.

operate any motor vehicle begins to deteriorate at BAC levels lower than 0.08 percent, increasing a driver's risk of being in a crash. In addition, studies from countries that have decreased their BAC laws to 0.05 percent, such as Austria, Denmark, and Japan, demonstrate that this is an effective policy to reduce fatalities. Therefore, the report recommends, state governments should enact laws criminalizing alcohol-impaired driving at 0.05 percent BAC, the federal government should incentivize this change, and enacting the new BAC limit should be accompanied by media campaigns and robust and visible enforcement efforts.

Alcohol-impaired driving is extremely expensive in terms of medical costs, earnings and productivity losses, legal costs, and vehicle damage. Strong evidence shows that higher alcohol taxes can reduce binge drinking and alcohol-related motor vehicle

crash fatalities, yet alcohol taxes have declined in inflation-adjusted terms at both federal and state levels, and taxes do not cover the costs attributable to alcohol-related harms. The report recommends that federal and state governments should increase alcohol taxes significantly.

As another strategy to reduce drinking to impairment, state and local governments should take appropriate steps to reduce alcohol availability, including placing restrictions on the number of on- and off-premises outlets and the days and hours of alcohol sales, the report says. Off-premises outlets are establishments where alcohol is sold but cannot be consumed, such as supermarkets, and on-premises outlets are establishments where alcohol is sold for consumption on-site, such as bars and restaurants. Federal, state, and local governments should also adopt or strengthen laws and dedicate enforcement resources to stop illegal alcohol sales to already-intoxicated adults and people under 21. Standards for



permissible alcohol marketing should be strengthened, too, as young people are at higher risk of driving under the influence and are readily swayed by such marketing.

Sobriety checkpoints, which aim to identify and arrest alcohol-impaired drivers as well as increase the perceived risk of arrest to deter driving while impaired,

have been shown to be effective in

both rural and urban areas when widely publicized.

The report also recommends increasing alternative transportation options, especially in rural areas, which are disproportionately affected by alcohol-impaired crashes and fatalities.

There were more than 1 million arrests for driving under the influence in 2015.

About 20 percent to 28 percent of first-time DWI offenders will repeat the offense, and repeat offenders are 62 percent more likely to be involved in a fatal crash. DWI courts, which are specialized courts whose purpose is to change behavior of high-need offenders through comprehensive monitoring and substance abuse treatment, have a positive track record at reducing repeat offense rates

and should be implemented by all states. To ensure tailored treatment for offenders who need it, the committee recommended effective evaluation, prevention, and treatment strategies for binge drinking and alcohol use disorders, including screening, brief intervention, and referral to treatment (SBIRT), cognitive behavioral therapy, and medication-assisted therapy.

All states also should require ignition interlocks — breath alcohol analyzers connected to the ignition system of a vehicle — for all offenders. States and other countries that have done so have experienced reductions in alcohol-related motor vehicle crash deaths. In addition, the Driver Alcohol Detection System for Safety (DADSS) is a promising in-vehicle technology that prevents a vehicle from operating when the driver's BAC exceeds the limit set by state law. Its eventual use could be enhanced through insurance policy discounts for drivers who adopt it.

In order to ensure coordination across federal agencies, the National Highway Traffic Safety Administration should create a federal interagency coordinating committee to develop and oversee an integrated strategy, ensure collaboration, maintain accountability, and share information among organizations committed to reducing alcohol-impaired driving.

— Dana Korsen



Getting to Zero Alcohol-Impaired Driving Fatalities: A Comprehensive Approach to a Persistent Problem (2018, 520 pp., ISBN 978-0-309-46826-8) is available from the National Academies Press, tel. 1-800-624-6242; \$85.00 plus \$6.50 shipping for single copies; also on the Internet at <www.nap.edu/catalog/24951>. Steven Teutsch, adjunct professor at UCLA Fielding School of Public Health, senior fellow at the Public Health Institute, and senior fellow at the Leonard D. Schaeffer Center for Health Policy and Economics at the University of Southern California, chaired the study, which was sponsored by the National Highway Traffic Safety Administration.

PREVENTING CRIME

An Analysis of **PROACTIVE POLICING** in America

Proactive policing is not a new phenomenon for American law enforcement.

The term first emerged in the 1960s to describe strategies aimed at preventing and reducing crime, which deviates from more traditional forms of policing that are reactive in nature. Proactive policing strategies were used extensively in the 1990s to combat the public perception that police organizations were losing the “War on Crime.” Today, these strategies are used widely in the United States. Do they actually have an impact on crime rates? A recent report from the National Academies says yes, but the answer to this question is also not so simple.

There are many factors that must be considered when assessing proactive policing outcomes. Regardless of its efficacy, a strategy cannot be permissible if it violates the law. This is especially of concern when dealing with Fourth Amendment rights, which protect against unreasonable search and



seizure, and the Equal Protection Clause of the 14th Amendment, which prohibits states from denying any person equal protections under the law. The committee that wrote the report also took into account the impacts proactive policing strategies have on communities, and whether they have an effect on communities’ fear of crime and their views toward the police. The committee’s examination of the research found that there is some support for the idea that proactive strategies that use aggressive stops and arrests to deter crime could increase the chance of a Fourth Amendment or an

Equal Protection violation, but there is not enough evidence to definitively link proactive policing to an infringement on personal rights. The research also finds that effective proactive policing strategies rarely have a negative effect on communities, but such strategies generally do little to improve community relations with the police. While community policing has been shown to



improve attitudes toward the police, on its own it has not been found to reduce crime.

Racial bias is of particular concern when assessing proactive policing strategies, as there are likely to be large racial disparities when police target high-risk places or peo-

ple. Surprisingly, there is relatively little research available that explores the role that racially biased behavior plays in proactive policing. “The committee felt that the lack of data on the role of racial bias in proactive policing was startling,” said David Weisburd, executive director of the Center for Evidence-Based Crime Policy at George Mason University and chair of the committee. “It’s critically important that we understand not simply the impacts of proactive policing on racial outcomes but also how race may impact the adoption of specific types of proactive policing.”

Overall, there is enough evidence that says that some proactive policing

strategies are effective, if the goal is to reduce crime in the short term. Hot spots policing, which involves focusing resources on particular areas with high crime rates, can reduce crime in both the designated location and the surrounding areas. Identifying the underlying causes of crime and then responding in an appropriate manner (e.g. improving recreational opportunities for youth) also reduces crime. Third party policing, in which business owners, public housing agencies, and other organizations are encouraged to help reduce crime problems, and localized stop-question-frisk strategies have also proved effective, although widespread implementation has produced mixed results. In the cases of predictive policing, closed circuit television, and broken windows policing, which targets misdemeanor offenses to prevent more serious crimes, insufficient evidence exists to draw any conclusions.

While there is sufficient evidence to support the adoption of some proactive policing strategies, the report points out the major gaps in the knowledge base concerning long-term outcomes and racial bias. It is time for a bigger investment in understanding the full effect of these strategies and whether they can be successfully implemented.

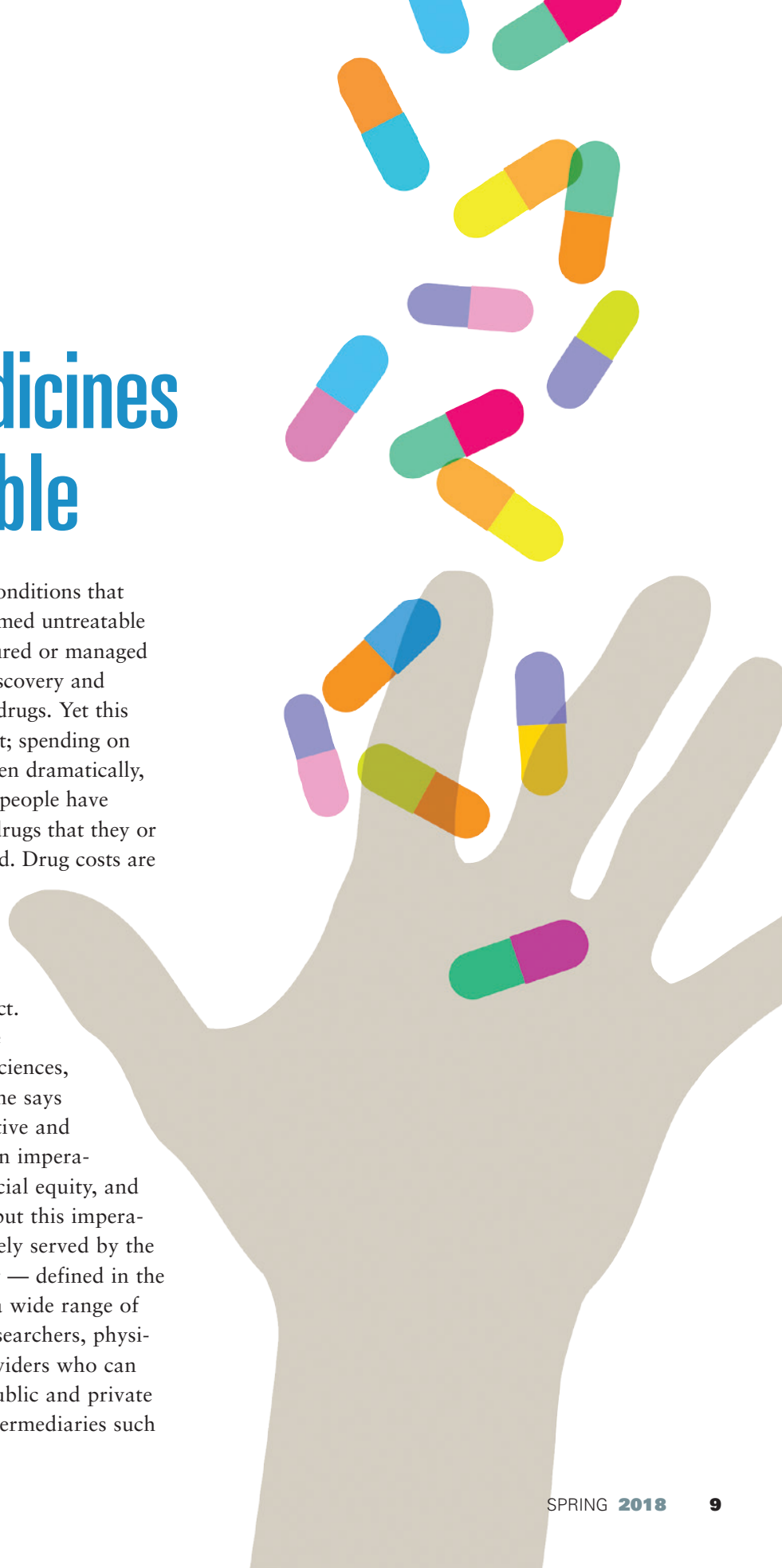
— Kacey Templin & Riya V. Anandwala

Proactive Policing: Effects on Crime and Communities (2018, 408 pp., ISBN 978-0-309-46713-1) is available from the National Academies Press, tel. 1-800-624-6242; \$60.00 plus \$6.50 shipping for single copies; also on the Internet at <www.nap.edu/catalog/24928>. The study was sponsored by National Institute of Justice of the U.S. Department of Justice and Laura and John Arnold Foundation.

A Prescription for Making Medicines Affordable

Many medical conditions that were long deemed untreatable can now be cured or managed effectively through the discovery and development of effective drugs. Yet this success has come at a cost; spending on prescription drugs has risen dramatically, to the point where many people have difficulty paying for the drugs that they or their family members need. Drug costs are a significant part of the nation's total spending on health care, which now equals 18 percent of the gross domestic product.

A new report from the National Academies of Sciences, Engineering, and Medicine says consumer access to effective and affordable medicines is an imperative for public health, social equity, and economic development, but this imperative is not being adequately served by the biopharmaceutical sector — defined in the report as encompassing a wide range of participants including researchers, physicians and other care providers who can prescribe medications, public and private payers of health care, intermediaries such



Consumer access to effective and affordable medicines is an imperative for public health, social equity, and economic development, but this imperative is not being adequately served by the biopharmaceutical sector.



as pharmacy benefit managers, health care organizations, and patient advocacy organizations. The report outlines eight recommendations with 27 actions for their implementation to improve the affordability of prescription drugs without discouraging the development of new and more effective drugs for the future.

Among the report's actions for drug pricing, Congress should modify existing legislation to allow the U.S. Department of Health and Human Services to directly negotiate prices with producers and suppliers of medicines, including acting on behalf of any relevant state agency that elects to participate in the process. Because prices tend to be lower when the purchaser has bargaining power that is at least comparable to that of the seller, the U.S. could achieve lower prices for prescription drugs by consolidating its bargaining power and providing greater flexibility in formulary design. A formulary describes which drugs a health care payer will cover for which disease indications and at what cost.

Drug manufacturers often pay other producers for the delayed entry into the market of generics and biosimilars (products that are demonstrated to be interchangeable with branded, FDA-approved products). In order to accelerate the market entry and use of safe and effective generics and biosimilars, the U.S. Department of Justice and the Federal Trade Commission should vigorously deter manufacturers from making these “pay-for-delay” agreements. They also should expand the enforcement of policies that preclude mergers and acquisitions of firms among companies possessing competing generics and biosimilars and a significant share of the market, as these strategies reduce consumer access to reasonably priced drugs.

Various participants in the biopharmaceutical supply chain point to other participants as the main contributors to high and rising drug costs. To help understand the root causes of price increases and when they are appropriate, Congress



should require disclosure of information from insurance plans about the average net prices paid for prescription drugs, including cost-sharing among patients' plans, and from biopharmaceutical companies about average net volume of and prices paid for drugs across each active sales channel. HHS should curate, analyze, and publicly report the data on a quarterly basis to the public and congressional committees, and the FTC should examine the data to identify and act upon any anti-competitive practices.

Large biopharmaceutical companies spend substantially more on marketing and administration than on research and development that could lead to new drugs, the report says, and their direct-to-consumer advertising of prescription drugs can

adversely influence consumer choices. Therefore, promoting the adoption of industry codes of conduct and discouraging direct-to-consumer advertising of prescription drugs as well as direct financial incentives for patients are important steps in solving this problem. In addition, clinicians, medical practices, and hospitals should also substantially tighten restrictions on pharmaceutical companies' direct visits to clinicians, the acceptance and use of free drug samples, special payments, and other inducements paid by biopharmaceutical companies.

Other changes that should be made to make medicines affordable are modifying insurance benefit designs to mitigate prescription drug cost burdens for patients, eliminating misapplication of funds and inefficiencies in federal discount programs that are intended to aid vulnerable populations, and ensuring that financial incentives to develop drugs for the prevention and treatment of rare diseases are not extended to widely sold drugs. — *Dana Korsen*

Making Medicines Affordable: A National Imperative (2017, 240 pp., ISBN 978-0-309-46805-3) is available from the National Academies Press, tel. 1-800-624-6242; \$65.00 plus \$6.50 shipping for single copies; also on the Internet at <www.nap.edu/catalog/24946>. Norman Augustine, former chairman and CEO of Lockheed Martin Corp. and former chairman of the National Academy of Engineering, chaired the study, which was sponsored by the Laura and John Arnold Foundation, Breast Cancer Research Foundation, Burroughs Wellcome Fund, the Commonwealth Fund, Milbank Memorial Fund, California Health Care Foundation, American College of Physicians, and the Presidents' Committee of the National Academies of Sciences, Engineering, and Medicine.



AN IN-DEPTH
LOOK AT THE
HEALTH EFFECTS OF

E-Cigarettes

Ever since electronic cigarettes hit the market a little over a decade ago, debate has persisted over the risks they may pose to human health. Millions of Americans use e-cigarettes regularly, and they are especially popular among teens and young adults, who use the devices at higher rates than other age groups.

In one of the most comprehensive studies on the topic ever conducted, a committee of the National Academies examined hundreds of peer-reviewed scientific studies on e-cigarettes and their health effects. Overall, the committee's report concludes, evidence suggests that while e-cigarettes are not without risks, they are likely to be far less harmful than conventional cigarettes. E-cigarettes have fewer and lower levels of toxic substances than conventional cigarettes. And even though there is substantial evidence that e-cigarettes are addictive, the risk and severity of dependence appears to be less than that for cigarette smoking.

Still, because the devices have only been in use for a brief time, their long-term health effects are not yet clear. And for many important health

Contrasting findings, combined with the lack of research on e-cigarettes' long-term effects, make it hard to reach simple conclusions about whether the devices have an overall positive or negative impact on public health.

outcomes, there are considerable unknowns. For example, there is no evidence to tell whether e-cigarette use is associated with cancer in humans, although limited evidence from animal studies supports the hypothesis that it might increase risk. Nor is there enough research to determine whether e-cigarette use is associated with heart disease or stroke.

Some research has examined e-cigarettes' impact on conventional smoking behavior — an area of considerable interest, given the many known health harms associated with the latter. Here, e-cigarettes' effects differ for youths and adults. Among young people, there is substantial evidence that e-cigarette use increases the risk of starting to smoke conventional cigarettes, though their long-term smoking behavior has not been studied. Among adult smokers, however, there is some evidence that e-cigarettes may help them quit. These contrasting findings, combined with the lack of research on e-cigarettes' long-term effects, make it hard to reach simple conclusions about whether the devices have an overall positive or negative impact on public health.

“E-cigarettes cannot be simply categorized as either beneficial or harmful,” said David Eaton, chair of the committee that

wrote the report, and dean and vice provost of the Graduate School of the University of Washington, Seattle. “In some circumstances, such as their use by non-smoking adolescents and young adults, their adverse effects clearly warrant concern. In other



cases, such as when adult smokers use them to quit smoking, they offer an opportunity to reduce smoking-related illness.”

There is a great need for continuing research, says the report, which lays out a number of areas for future studies. For example, research should examine the impacts of e-cigarette use on respiratory airways, the effects of secondhand exposure, and the mechanisms by which e-cigarette use affects conventional smoking. — *Sara Frueh*

Public Health Consequences of E-Cigarettes (2018, 680 pp., ISBN 978-0-309-46834-3) is available from the National Academies Press, tel. 1-800-624-6242; \$105.00 plus \$6.50 shipping for single copies; also on the Internet at <www.nap.edu/catalog/24952>. The study was sponsored by the U.S. Food and Drug Administration.



The Gift of Life

IMPROVING THE QUALITY AND QUANTITY OF ORGANS FOR TRANSPLANTATION

Over 115,000 Americans are currently in need of an organ transplant. While the last few decades have seen improvements in outcomes for transplant recipients and in the number of organs donated, the demand for organs still far exceeds the supply. To help close this gap, a recently released report from the National Academies suggests taking a closer look at organ donor intervention research.

Until recently, research related to organ donation has focused primarily on improving the transplantation process and health outcomes for recipients. Organ donor intervention research tests and assesses clinical interventions — for example, medications, devices, and donor management protocols — that are administered to the deceased donor or to the target organ with the aim of maintaining or improving the quality of donated organs. This type of research

can bring up ethical questions about who should be considered a human subject, what are the processes of fully informing and gaining consent from potential recipients of research organs, and how researchers can ensure that their studies do not threaten the distribution of a scarce resource. However, intervention research is vital for increasing the number of viable organs recovered, the report says. In 2016, more than 27,000 organs were transplanted from nearly 10,000 deceased donors, yet

another 5,000 donated organs could not be used, the result of any number of factors — for instance, the deceased’s cause of death, poor organ function, or abnormalities in the donated organ. The committee that carried out the study pointed out that intervention research has the potential to help address this issue, although not without challenges.

Once an organ becomes available for transplant, the process must move quickly. The decision to accept an organ is usually made within an hour after receiving the offer, and surgery to remove the organ proceeds immediately after that. Organ donor intervention research, if authorized, takes place either prior to organ recovery or after the organ is recovered but before transplantation.

“The very brief time frame in which donor intervention research must be conducted to maintain organ viability and ensure successful transport to the recipient, coupled with the fact that organs from a single donor may go to multiple recipients in different transplant centers throughout the United States, adds to the complexities of this research,” said James Childress, John Allen Hollingsworth Professor of Ethics Emeritus at University of Virginia, and the chair of the study’s committee.

To improve intervention research efforts, the report recommends creating standardized language and materials to be used when discussing organ donation (including the need for research) with a potential donor, as well as creating one national donor registry that can be accessed by all organ procurement organizations. To ensure equitable, expedient, and high-quality organ donor intervention research,

a centralized management system should be implemented in order to coordinate research that is both geographically and clinically dispersed throughout the nation.

A donated organ is a gift that can provide a second lease on life. Improvements to organ donor intervention research can help to increase the number of quality organs available and, ultimately, save many lives. — *Kacey Templin & Dana Korsen*



Opportunities for Organ Donor Intervention Research: Saving Lives by Improving the Quality and Quantity of Organs for Transplantation (2017, 170 pp., ISBN 978-0-309-46487-1) is available from the National Academies Press, tel. 1-800-624-6242; \$55.00 plus \$6.50 shipping for single copies; also on the Internet at <www.nap.edu/catalog/24884>. The study was sponsored by the American Association for the Study of Liver Diseases; American Society of Transplant Surgeons; American Society of Transplantation; Association of Organ Procurement Organizations; Gift of Life Donor Program; Health Resources and Services Administration; Laura and John Arnold Foundation; National Heart, Lung, and Blood Institute; National Institute of Allergy and Infectious Diseases; National Institute of Diabetes and Digestive and Kidney Diseases; National Kidney Foundation; OneLegacy Foundation; and the Transplantation Society.



On the **Right Track?**

New Report Examines Safety Ramifications of Moving Increased Supplies of Oil, Ethanol, and Natural Gas Via Rail, Pipeline, and Waterway

For more than a decade, the United States has been experiencing what is often called a domestic energy revolution with increased production of crude oil, natural gas, natural gas liquids, and corn-based ethanol. However, this upsurge has placed an unforeseen demand on the transportation sector — to move far more of these volatile forms of energy around the nation than ever before.

Given limited access to transmission pipelines, producers of oil and natural gas liquids from many parts of the country have turned to trains and barges to transport their products to distant markets, as have ethanol plants in the Midwest, which are located far from some of the country's largest consumers of this gasoline additive on the East and West Coasts and in the Southeast and Southwest.

Railroad tank cars and tank barges are hauling greater quantities of oil and fuel ethanol over longer distances, often on routes passing through communities that have little, if any, experience with regular and high levels of flammable liquids traffic.

Safety concerns have cropped up about the stress being placed on the transportation system. Railroad tank cars and tank barges are hauling greater quantities of oil and fuel ethanol over longer distances, often on routes passing through communities that have little, if any, experience with regular and high levels of flammable liquids traffic.

In light of these changes, the National Academies of Sciences, Engineering, and Medicine conducted a study of the three principal long-distance modes of energy transportation — rail, pipeline, and waterways — to make policy recommendations that could help reduce the likelihood of future incidents involving domestic energy shipments as well as ensure an effective emergency response when incidents do occur. The study focused on the individual safety concerns for each of the three transportation modes; however, it did not compare the safety performances against one another. One reason for this is that certain modes of transportation are not viable alternatives in some regions or for some shipments.

The committee that carried out the study found cause for concern regarding the safe transport of these hazardous materials, specifically in relation to railroad track defects, rural emergency response prepared-



ness, and the older tank car designs used in multi-car tanker trains. Nevertheless, pipelines and barges have accommodated large portions of the growth in domestic energy transportation without major new safety problems and within the basic framework of their long-standing regulatory and safety assurance systems. The committee's report stresses that to the credit of service providers from all three transportation modes as well as their safety regulators, the vast majority of energy supplies have been transported without incident, enabling the country to capitalize on its new energy resources and manage the safety risks associated with their transportation.

The committee said that railroads have an opportunity to create a more robust

safety assurance system for moving crude oil and ethanol, one that resembles that of the maritime carriers. In particular, incomplete understanding of the dynamics of tank-car train derailments and a lack of clear guidelines and resources for state



and local emergency responders both continue to present safety risks.

As tank cars that are compliant with new design specifications are phased in, tank cars built to older specifications that are less crashworthy and less resistant to thermal failures may continue to be used for several years. Preventing the derailment of these cars is imperative, the committee said. Post-incident investigations of severe flammable liquids train derailments indicate track wear and defects are commonly the cause.

In addition, the committee found that many of the communities traversed by trains moving crude oil and ethanol lack familiarity with responding to large-scale incidents involving trainloads of flammable liquids, mainly because this type of traffic is a relatively new phenomenon. Industry and government authorities face the challenge of ensuring that appropriate response procedures are widely known and that existing training opportunities are exploited,

especially among rural communities served by volunteer fire departments.

Regarding the safe transport of domestic oil and gas via pipelines, the committee found no new safety problems have emerged from the increased use of pipelines transporting larger amounts of these energy sources. However, substantially more pipeline mileage and higher volumes may result in more pipeline releases over time, simply because of increased exposure. The safety impact is likely to depend on the extent to which new pipeline technologies, leak monitoring systems, and more vigilant and capable integrity management programs are effective in protecting the newer pipelines and the older ones that connect to them.

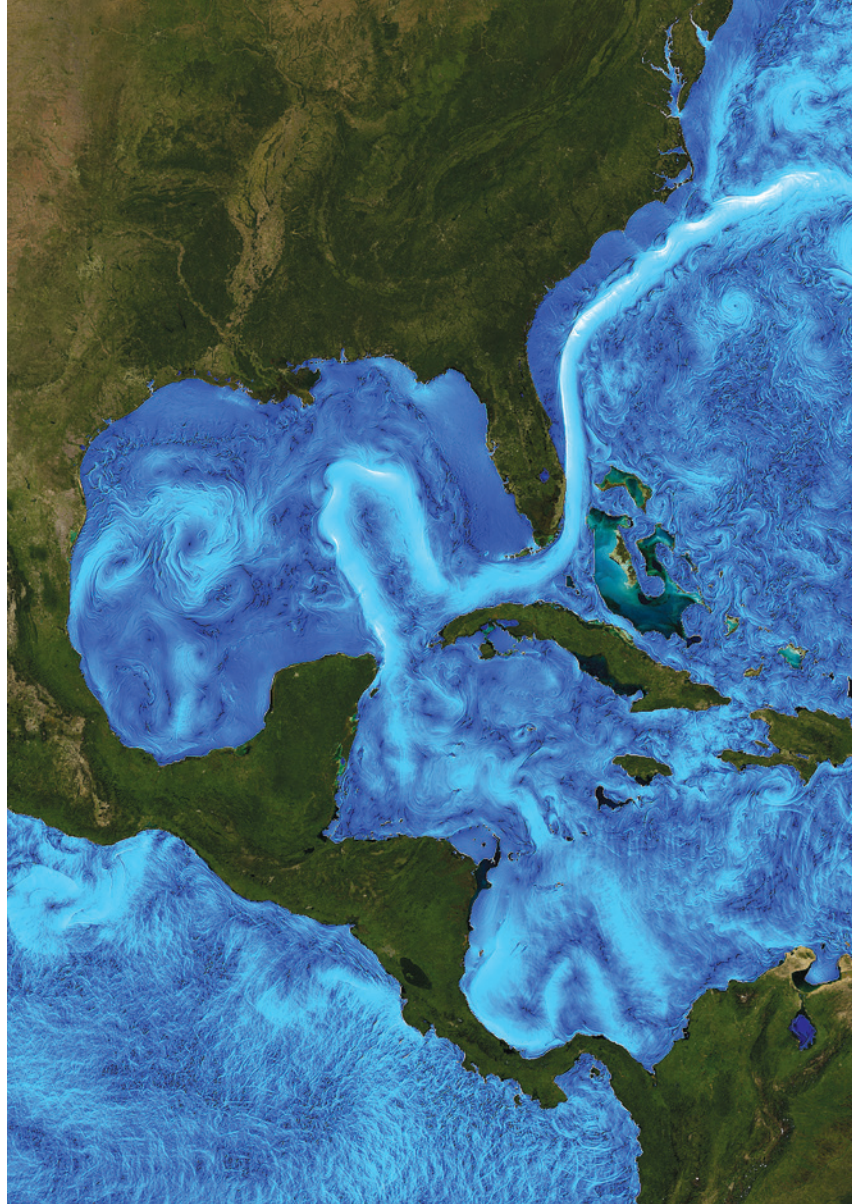
When the committee examined the safety record of energy liquids movement by waterways, it found no reports of ethanol or natural gas liquids releases over the past 10 years and only rare reports of crude oil releases. A series of incidents 30 years ago led to statutory and regulatory reforms that produced a robust and anticipatory safety culture that has dealt well with fluctuations in the demand for oil and other energy liquids and can serve as a model for other energy transport modes. — *Jennifer Walsh & Josh Blatt*

Safely Transporting Hazardous Liquids and Gases in a Changing U.S. Energy Landscape (2017, 144 pp., ISBN 978-0-309-46690-5) is available only online at <www.nap.edu/catalog/24923>. The committee was chaired by Paul G. Gaffney II, president emeritus, Monmouth University, Columbia, S.C. The study was sponsored by the Transportation Research Board of the National Academies of Sciences, Engineering, and Medicine.

The Loop Current System (LCS) — a shifting current of warm water through the Gulf of Mexico — influences the region's oil and gas operations, hurricane intensity, coastal and ocean ecosystems, oil spill response, fisheries, maritime commerce, economy, and communities that depend on Gulf resources. Yet, despite decades of research, important questions about the dynamics of the LCS remain unanswered, making it difficult to predict its path.

The LCS flows northward through the Yucatan Channel into the Gulf and then eventually meanders southward and then eastward before exiting at the Florida Straits and joining the Gulf Stream. However, the Loop Current's influence on the Gulf of Mexico varies greatly depending on whether it is in a retracted state, when its effect is minimal, or a more northerly, extended state, which brings a large mass of warm water and strong currents into the Gulf. In addition, circular currents known as eddies — which can be 100 to 200 miles in diameter — occasionally separate from the main flow of the loop and slowly migrate into the western Gulf.

To date, most scientific observations of the LCS have been limited to ocean surface features and satellite data, and although there have been a number of field studies of the full water-column from ocean surface to seafloor, they were of limited geographic scope and over short time periods. While this research has increased what we know about the LCS, significant gaps remain in understanding the formation, variability, and structure of the system and its interaction with other dynamic processes in the Gulf.



Better Understanding of the Gulf of Mexico's Loop Current

Would Offer Major Benefits
to the Region

A new report from the National Academies of Sciences, Engineering, and Medicine calls for an international, multi-institutional comprehensive campaign of research, observation, and analysis that would help improve understanding and prediction of the LCS. The proposed suite of complementary research efforts would provide critical information to help promote safer offshore operations, better understand the Gulf's complex oceanographic systems, facilitate disaster response, help protect coastal communities, protect and manage ecological resources, and predict and forecast weather and climate impacts.

"Improving our predictive skills and understanding of the Loop Current System is critical to operational safety and a variety of human activities in the Gulf," said Paul G. Gaffney II, chair of the committee that wrote the report, a retired Navy vice admiral, and president emeritus of Monmouth University. "Moreover, improving ocean modeling in the Gulf will also inform prediction efforts in other ocean basins."

Knowing much more about the LCS could provide many benefits. For example, the lack of real-time, in situ observations in the deep ocean after the Deepwater Horizon oil spill made it difficult for first responders to track oil under the ocean's surface. Better information could have improved spill response and recovery operations. In addition, when the LCS is in its extended state, its strong currents pose significant operational safety concerns for oil and gas operations, causing costly slowdowns or shutdowns. Understanding the factors and dynamics that cause

the LCS extended state could help the industry be better prepared. And because the position and dynamics of the LCS can cause hurricanes in the Gulf to intensify rapidly, better knowledge could greatly help coastal communities prepare and protect vulnerable assets.

Estimated to take about 10 years and cost between \$100 million and \$125 million, the report's research campaign consists of 30 recommendations for both near-term and long-term activities, which are divided into observational components, technology enhancements, analyses and theory, and data assimilation and numerical modeling techniques needed to provide critical information about the LCS. Implementation of the recommendations will help guide future funding investments by the National Academies' Gulf Research Program, as well as U.S. federal agencies, Mexican and Cuban oceanographic research entities, research institutions, and other ocean science sponsors.

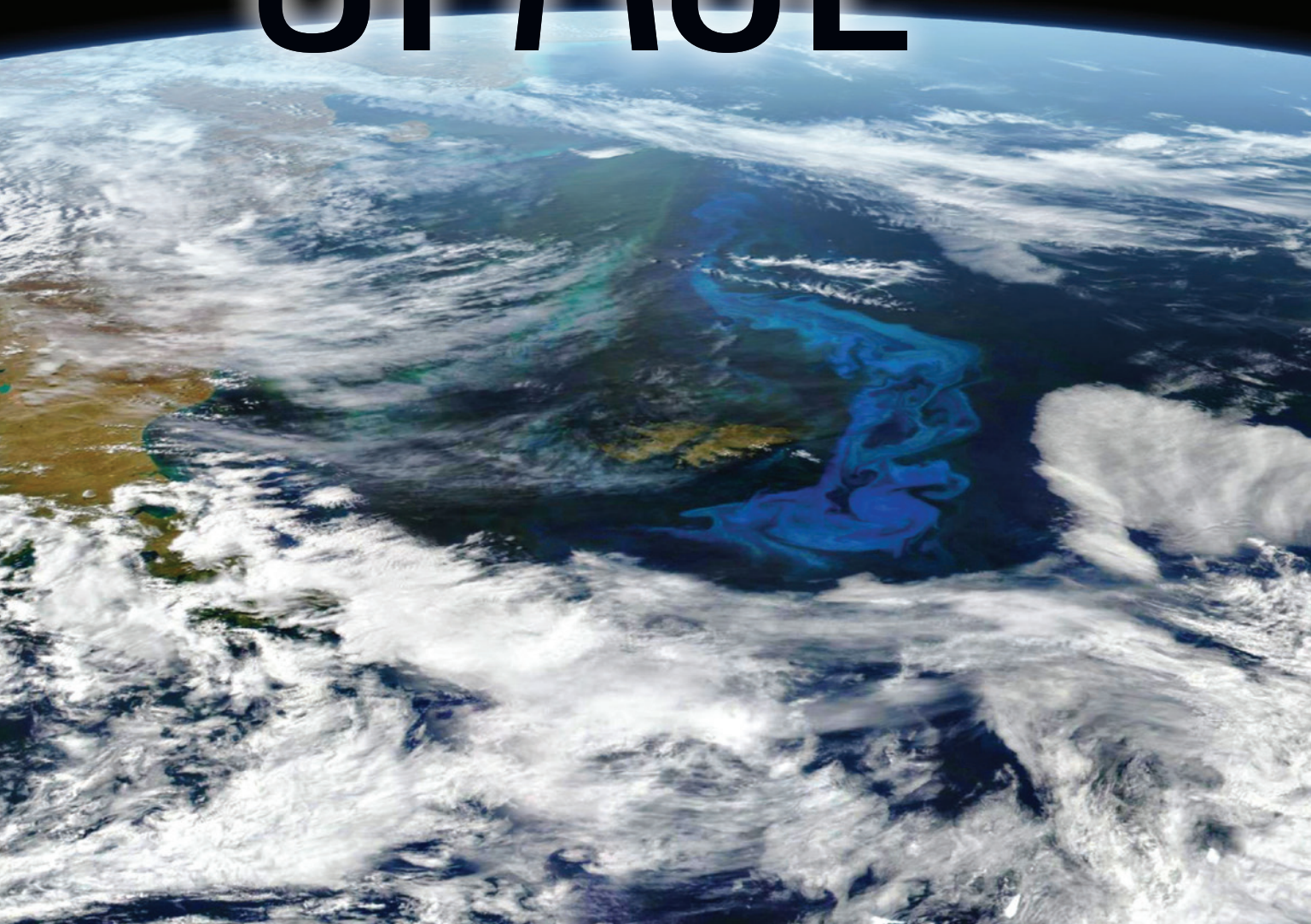
— *Molly Galvin*

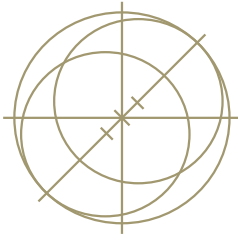
Understanding and Predicting the Gulf of Mexico Loop Current: Critical Gaps and Recommendations (2018, 110 pp., ISBN 978-0-309-46220-4) is available from the National Academies Press, tel. 1-800-624-6242; \$36.00 plus \$6.50 shipping for single copies; also on the Internet at <www.nap.edu/catalog/24823>. The study was sponsored by the National Academies' Gulf Research Program.

Earth Observations from

SPACE

**New Decadal
Survey Outlines
Key Earth Science
Priorities for the
Next Decade**



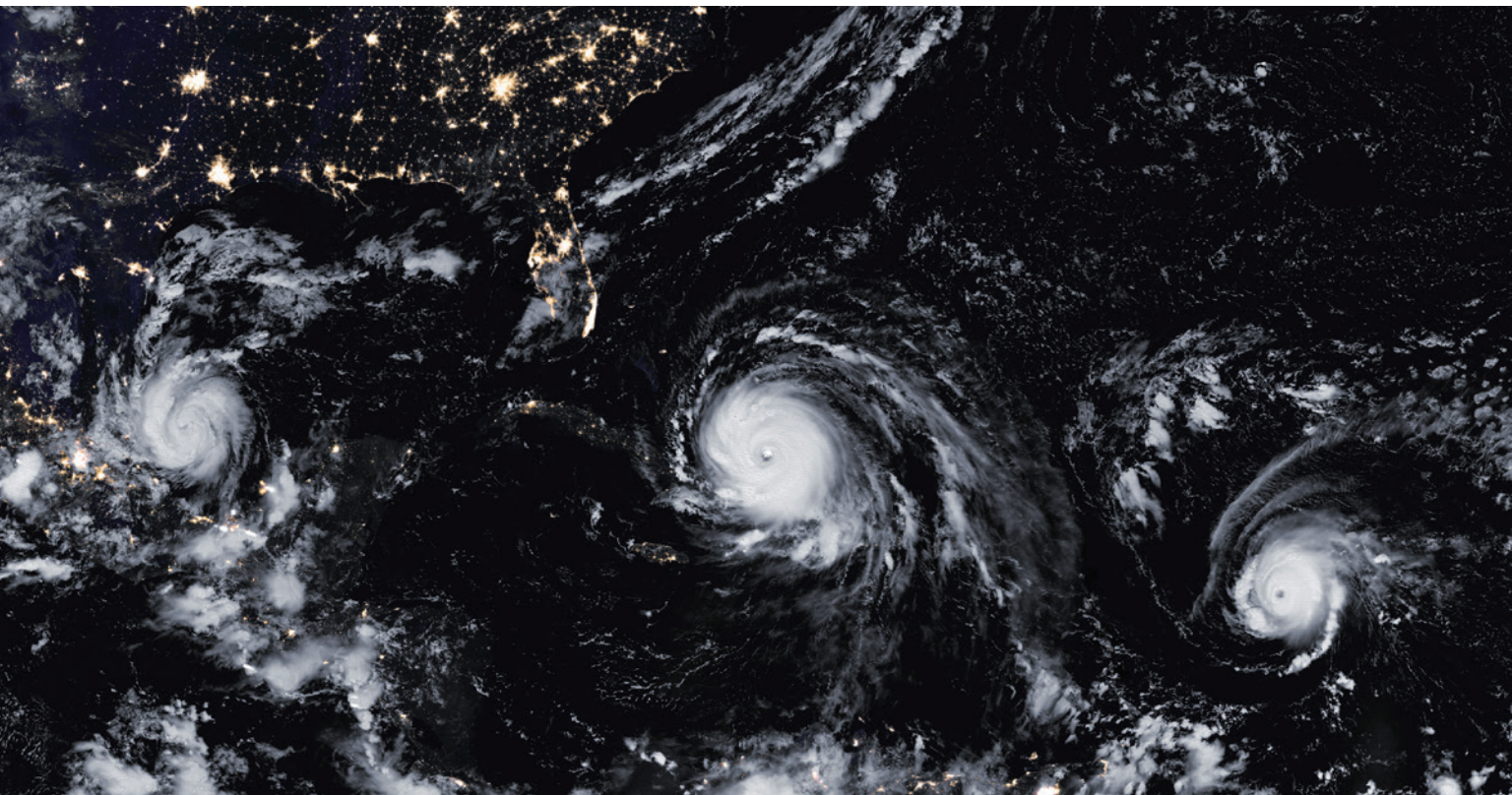


ver the last decade, space-based Earth observations, which provide a unique and global perspective of Earth, along with complementary in situ observations, have transformed our scientific understanding of the planet, revealing it to be an integrated system of dynamic interactions between and among the atmosphere, ocean, land, cryosphere, and human society. Information derived from Earth observations are ubiquitous, with applications ranging from the forecasting of weather and its extremes to drought and air quality. Agricultural and ocean productivity, national security (for example, naval operations), and the impacts of a changing climate are but a few of the areas where space-based observa-

tions are increasingly recognized as essential to our health and well-being.

To continue advancing such knowledge for the next decade, a new report from the National Academies of Sciences, Engineering, and Medicine calls for NASA, the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Geological Survey (USGS) to implement a coordinated approach for their space-based environmental observations. *Thriving on Our Changing Planet*, the 2017-2027 decadal survey for Earth science and applications from space, provides guidance to the sponsoring agencies on the construction of a robust, resilient, and balanced U.S. program of Earth observations from space, as well as recommendations on how to leverage

While meteorologists use many tools to track hurricanes, satellites provide a unique perspective on clouds, rainfall, sea surface temperatures, and more. The Visible Infrared Imaging Radiometer Suite on the Suomi National Polar-Orbiting Partnership satellite captured the data to create this composite, showing cloud imagery combined with data on city lights, of hurricanes Katia, Irma, and Jose as they appeared in the early hours of Sept. 8, 2017.



opportunities offered by new technologies, new providers of Earth information, and increased opportunities for international collaboration and cooperation.

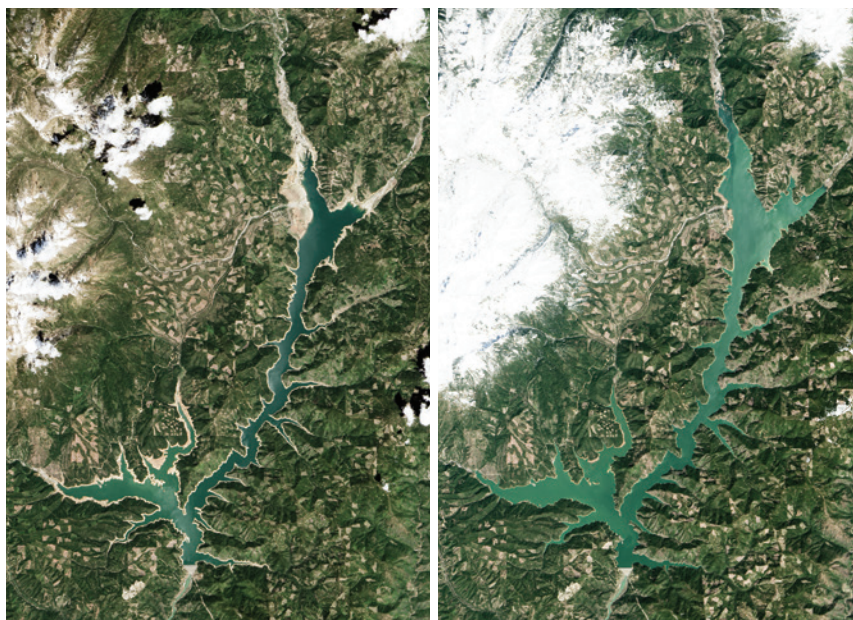
The committee that wrote the report developed a set of 35 key questions that address areas in which advances in Earth science and information capabilities are most needed to improve knowledge about the complex Earth system and to facilitate the development of numerous applications that enable a sustainable and thriving society. Some of the top priority questions are:

How can environmental predictions of weather and air quality be extended to seamlessly forecast Earth system conditions at lead times of one week to two months?

How do anthropogenic changes in climate, land use, water use, and water storage interact and modify the water and energy cycles, and what are the short- and long-term consequences?

What processes determine the long-term variations and trends in air pollution and their subsequent long-term recurring and cumulative impacts on human health, agriculture, and ecosystems?

To address such questions, the committee recommended implementing an innovative observing program that builds on the existing and planned instruments and satellites of the U.S. and the international community. The proposed program reflects new needs associated with eight priority observations — five directed at aerosols, clouds and precipitation, Earth's bulk mass movements, global land and vegetation characteristics, and deformation and changes within the Earth's surface, and three others to be selected competitively from among seven candidates. Each of these is to be



On April 29, 2015, Northern California's Trinity Lake stood at 59 percent of its historical average level for that date (left); on April 2, 2017, it stood at 114 percent (right). High-resolution satellite data play an important part in the study of drought, water storage, and precipitation. These images were acquired by the Operational Land Imager on Landsat 8.

measured through a space-based instrument or suite of instruments, and together would ensure effective exploration of the decadal survey's highest priorities.

Federal investments in Earth observation capabilities have failed to keep pace with the increasing information needs of businesses and individuals and the overall value of this information to the nation, the report says. Although budget constraints will remain a practical concern during the next decade in terms of progress with new space-based observational capabilities, the committee recommended innovative methods for achieving progress within those constraints. — *Riya V. Anandwala*

Thriving on Our Changing Planet: A Decadal Strategy for Earth Observation from Space (2018, 700 pp., ISBN 978-0-309-46757-5) is available from the National Academies Press, tel. 1-800-624-6242; \$104.00 plus \$6.50 for single copies; also on the Internet at <www.nap.edu/catalog/24938>. The committee was co-chaired by Waleed Abdalati, director of the Cooperative Institute for Research in Environmental Sciences at University of Colorado, Boulder, and William B. Gail, co-founder and chief technology officer of Global Weather Corp., Boulder, Colo. The study was sponsored by the NASA, NOAA, and USGS.



In the Event of an Emergency

IMPROVING PUBLIC SAFETY DURING SEVERE WEATHER AND DISASTERS

Our ability to observe and predict severe weather events and other disasters has advanced markedly, yet this progress does not always translate into similar advances in the systems used in such circumstances to protect lives. A more cohesive alert and warning system that integrates public and private communication mechanisms and adopts new technologies quickly is needed to deliver critical information during emergency situations. At the same time, better understanding of social and behavioral factors would improve the ways we communicate about hazards, inform response decisions such as evacuations, develop more resilient urban infrastructure, and

strengthen other steps we take to enhance weather readiness.

Two recent reports by the National Academies of Sciences, Engineering, and Medicine propose ways to improve public safety and resilience in the face of extreme weather and other disasters.

A Needed Evolution of Emergency Alert Systems

As technology advances, government systems such as Wireless Emergency Alerts and the Integrated Public Alert and Warning System will need to evolve, and their transformation should be informed by both technological and social and behavioral sciences research, says *Emergency Alert and Warning Systems: Current Knowledge and Future Research Directions*.

Emergency alerts and warnings are sent out by government agencies through broadcast media and wireless messaging. But the report notes that the information ecosystem has broadened to also include

a wider variety of delivery mechanisms including first-person reports on social media platforms. Private companies like Google and Facebook are also collecting information from emergency management agencies to issue notifications. The committee that wrote the report said government-designed systems need to fit into this larger structure of communication.

The committee envisioned an alert system that continually takes advantage of new technologies and knowledge emerging from events and research. The report outlines key research questions and areas of study. One example is to improve geotargeting by performing more research to determine the best ways to graphically display the location of an individual in a risky situation and how visualizations can be used to best illustrate the location of the message receiver relative to the area of impact.

Improving the Weather Enterprise

Weather forecasts and warnings are being made with greater accuracy, geographic specificity, and lead time, which allow individuals and communities to take appropriate protective measures. Yet, as recent hazardous weather events have illustrated, social and behavioral factors — including people's contexts, experiences, knowledge, perceptions, and attitudes — shape responses to weather risks, says *Integrating Social and Behavioral Sciences Within the Weather Enterprise*.

As efforts to advance meteorological research continue, it is essential for government agencies, industry, and academic institutions — all part of the weather enterprise — to integrate social and





behavioral sciences into their work. The report suggests strategies to better engage researchers and practitioners from multiple social science fields, to more effectively apply relevant research findings, and to foster more cooperation on this endeavor among public, private, and academic sectors.



A better understanding of the social and behavioral aspects of weather readiness will help not only to design more effective forecasts and warnings but also to reduce

vulnerability and mitigate risks of hazardous weather well before an event strikes and to better support emergency management and response efforts.

The National Oceanic and Atmospheric Administration will need to play a central role in driving this research forward in order to achieve the agency's goals of improving the nation's weather readiness, the report

says. Interagency cooperation with the National Science Foundation, Federal Emergency Management Agency, Federal Highway Administration, and others is also critical for supporting and applying research at the social science and weather interface. The committee that wrote the report detailed several possible means for NOAA to advance its capacity to support social and behavioral science research, including innovative public-private partnerships for interdisciplinary weather research and social science-focused research programs within NOAA's Cooperative Institutes.

Some examples of critical research needs highlighted in the report include: understanding how forecasters, broadcast media, emergency and transportation managers, and private weather companies interact and create and disseminate information; learning how to better reach and inform populations that are particularly vulnerable to hazardous weather; and figuring out how new communication technologies affect message design and are changing people's weather information access, interpretations, preparedness, and response.

— Riya V. Anandwala

Emergency Alert and Warning Systems: Current Knowledge and Future Research Directions (2017, 104 pp., ISBN 978-0-309-46737-7) is available from the National Academies Press, tel. 1-800-624-6242; \$40.00 plus \$6.50 for single copies; also on the Internet at <www.nap.edu/catalog/24935>. Ramesh Rao, director, UCSD Division, California Institute for Telecommunications and Information Technology, chaired the study, which was sponsored by the U.S. Department of Homeland Security Science and Technology Directorate, First Responders Group.

Integrating Social and Behavioral Sciences Within the Weather Enterprise (2018, 198 pp., ISBN 978-0-309-46422-2) is available from the National Academies Press, tel. 1-800-624-6242; \$60.00 plus \$6.50 for single copies; also on the Internet at <www.nap.edu/catalog/24865>. The committee was co-chaired by Ann Bostrum, Weyerhaeuser Endowed Professor of Environmental Policy, University of Washington, Seattle, and William H. Hooke, associate executive director, American Meteorological Society. The study was sponsored by NOAA and the U.S. Department of Transportation.



Laser Focus

IMPROVING THE NATION'S DOMINANCE IN HIGHLY INTENSE, ULTRAFAST LASER TECHNOLOGY

The laser has revolutionized many areas of science and society, providing bright and versatile light sources that have transformed how we investigate science and enabled trillions of dollars of commerce.

In 1898, H.G. Wells made a case for high-intensity laser science, creating an enduring popular image of a tool that projects enormous energy as intense beams of light. This was 62 years before the first laser was ever fired and 17 years before Albert Einstein derived the notion of stimulated light amplification. The laser has revolutionized many areas of science and society, providing bright and versatile light sources that have transformed how we investigate science and enabled trillions of dollars of commerce.

Now a second laser revolution is underway with pulsed petawatt-class lasers (1 petawatt is equal to 1 million billion watts) that deliver nearly 100 times the total world's energy consumption rate concentrated into a pulse that lasts less than one picosecond, or one-trillionth of a second.

Intense, ultrafast lasers have broad applicability beyond science, including to nuclear weapons stockpile stewardship, manufacturing, and medicine.

To illustrate the time scale, a picosecond is to one second what one second is to more than 31,000 years. Such laser sources create conditions that can accelerate and collide intense beams of elementary particles, drive nuclear reactions, heat matter to conditions found in stars, or even create matter out of an empty vacuum. Although pulsed petawatt-class lasers originated in the U.S., research-funding agencies in Europe and Asia began in the last decade to invest heavily in new collaborations and facilities that will employ these high-intensity lasers for many areas of science.

Now, the U.S. is losing ground in highly intense, ultrafast lasers to Europe and Asia, according to a recent report from the National Academies. Currently, 80 percent to 90 percent of the high-intensity laser systems are overseas, and all of the highest power research lasers in construction or already built are overseas as well. The report makes a series of recommendations that would improve the nation's position in the field.

The committee that carried out the study and wrote the report concluded that intense, ultrafast lasers have broad applicability, including to nuclear weapons stockpile stewardship, manufacturing, and medicine. The main application

of high-intensity lasers to the science of DOE's Stockpile Stewardship Program is to produce bright, penetrating, high-energy X-rays for radiography of high-energy matter. These lasers can deposit a large amount of energy on a sub-picosecond time scale, making them a unique tool to probe inertially confined nuclear fusion experiments and high-energy-density physics occurring on a much longer time scale.



In manufacturing, high-intensity lasers can be used for precision cutting and to drill clean, small, deep holes in materials without damaging the surrounding material. For instance, the technology is now commonly used in the medical industry for fabricating high-quality surgical stents that need micron size features, such as 1 micron diameter holes with large lengths. Ultrahigh intensity lasers also show promise for both medical imaging and as the source of intense particle beams for cancer therapies.

The committee concluded that the large and talented U.S. technical community already associated with high-intensity lasers is fragmented across different disciplines, and coordination between industry and government is limited

and often inadequate. Therefore, DOE should create an extensive national network — one that includes universities, industry, and government laboratories, in coordination with the Office of Science and Technology Policy, the research arms of the U.S. Department of Defense, National Science Foundation, and other federal research organizations — as the cornerstone of a national strategy

beyond the current state of the art in areas critical to frontier science, such as peak power, repetition rate, pulse duration, wavelength, and focusable intensity.

Co-location of high-intensity lasers with existing infrastructure, such as particle accelerators, has been recognized as a key advantage of the U.S. laboratories over the Extreme Light Infrastructure concept in Europe, the committee said. Based on this,



The U.S. is losing ground in highly intense, ultrafast lasers to Europe and Asia.

to support science, applications, and technology of intense and ultrafast lasers.

Moreover, the committee found, no single federal agency currently acts as the steward for high-intensity laser-based research, nor does cross-agency stewardship exist in the United States. Programs are carried out under sponsorship of several different federal agencies according to their various missions — without the overall coordination that exists in Europe. To increase integration and coordination, the committee recommended that research agencies — including DOD, DOE, NSF, and others — engage scientific stakeholders within the network to define what facilities and laser parameters will best serve research needs, emphasizing parameters

it recommended that the DOE plan for at least one large-scale, open-access, high-intensity laser facility that leverages other major science infrastructure in the DOE complex. — *Jennifer Walsh*

Opportunities in Intense Ultrafast Lasers: Reaching for the Brightest Light (2018, 346 pp., ISBN 978-0-309-46769-8) is available from the National Academies Press, tel. 1-800-624-6242; \$150.00 plus \$6.50 shipping for single copies; also on the Internet at <www.nap.edu/catalog/24939>. Follow the conversation on social media using #NASEMlaser. The study committee was chaired by Philip H. Bucksbaum, Marguerite Blake Wilbur Chair in Natural Science; professor of photon science, applied physics, and physics; and director, Stanford PULSE Institute; Stanford University, Stanford, Calif. The study was sponsored by the U.S. Department of Energy Office of Science, National Nuclear Security Administration, Office of Naval Research, and the Air Force Office of Scientific Research.

WHEN SCIENCE IS A DOUBLE-EDGED SWORD

Safeguarding Dual-Use Research From Misuse

While no bioterror incidents have been reported in the United States since the 2001 anthrax attacks, concerns about bioterrorism persist — and intensify when scientists conduct research that could be dangerous in the wrong hands.

In 2011, for example, two research teams from the U.S. and the Netherlands sought to publish research that identified genetic mutations that would make H5N1 avian influenza easier to transmit from person to person. The prospect of publication raised fears that terrorists would misuse the research to cause a pandemic.

But openly disseminating research results on dangerous pathogens can also have beneficial effects, such as aiding the development of vaccines and other countermeasures. Research that has the potential for both good and harmful applications is called “dual use” research.

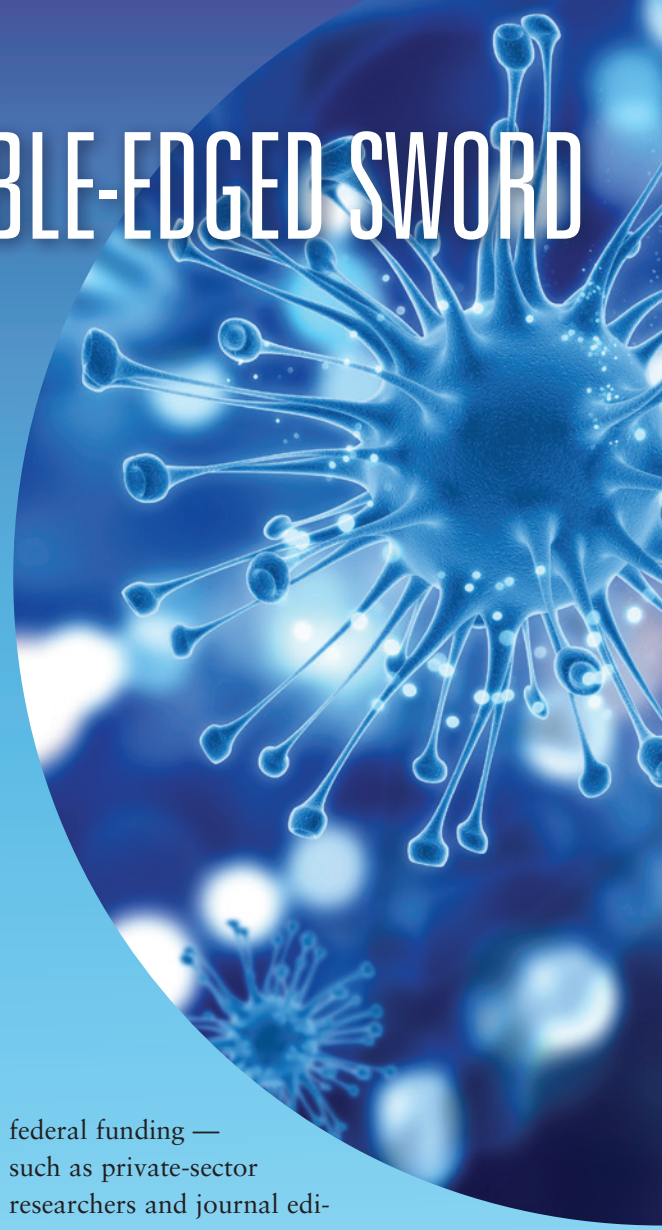
While the U.S. has a solid record in conducting biological research safely, the policies and regulations governing dual-use research in the life sciences are fragmented, according to a recent National Academies report. It identifies multiple shortcomings in the policies and practices surrounding this research.

For example, there are gaps in who is given guidance about dual-use research. Scientists who carry out federally funded research or who work at federally funded institutions are offered advice on how to develop plans to mitigate biosecurity risks when appropriate. But there is no established process for those not receiving

federal funding — such as private-sector researchers and journal editors — to seek advice from U.S. government experts on how to manage dual-use research or manuscripts.

In addition, current federal policies on dual-use research of concern pay too little attention to certain types of research, and too much to others. The policies — which focus on 15 select agents and toxins and seven types of experiments — do not capture biosecurity concerns in all relevant areas of life sciences research, especially in emerging areas such as genome editing. Meanwhile, certain types of studies that do not need stringent oversight are restricted.

An important factor hampering efforts to address biosecurity risks is a lack of





awareness of these issues among life scientists, the report says. Those training to become life scientists are rarely introduced to the topic in a systematic way. Education and training programs at the undergraduate, graduate, and postgraduate levels generally do not include courses or discussions about dual-use research, unless the student or trainee is involved with a select agent. Even in these cases, the primary focus is on preventing accidental releases of pathogens, rather than protecting against intentional misuse.

While the committee that wrote the report was not tasked with recommending specific solutions to these problems, it identified multiple elements as important in dealing with dual-use research of concern.

For instance, ongoing, interactive education and training about dual-use issues is imperative for researchers and others in the life sciences community. Another key element is the development of uniform roles and responsibilities for publishers.

But ideally, dual-use issues should be considered before research reaches the publication phase, the committee said. Interventions are more likely to be effective when they happen at an early stage — before the research is carried out, or during research when an unusual finding is encountered. That way, appropriate actions can be taken to reduce risks, such as deciding not to fund the research, classifying it, or putting mitigation plans in place. — *Sara Frueh*

Dual Use Research of Concern in the Life Sciences: Current Issues and Controversies (2017, 114 pp., ISBN 978-0-309-45888-7) is available from the National Academies Press, tel. 1-800-624-6242; \$45.00 plus \$6.50 shipping for single copies; also on the Internet at <www.nap.edu/catalog/24761>. Richard A. Meserve, Senior Of Counsel at Covington & Burling LLP, Washington, D.C.; and Harold E. Varmus, Lewis Thomas University Professor at Weill Cornell Medicine, Cornell University, New York City, co-chaired the study, which was sponsored by the Burroughs Wellcome Fund, Gordon and Betty Moore Foundation, Alfred P. Sloan Foundation, and the Federal Bureau of Investigation of the U.S. Department of Justice.



Keeping Up With Computer Science Enrollments

College and university computer science departments are seeing a surge in undergraduate students signing up for majors and courses. Since 2009, the number of bachelor's degrees in computer and information sciences awarded at U.S. nonprofit institutions of higher learning has increased by 74 percent, and there's no sign that enrollments will fall any time soon.

Multiple factors are driving this growth, including the job market, where jobs in computer occupations have increased even faster than the number of computer science graduates being produced. Expertise in cybersecurity, data science, and machine learning are in particularly high demand.

In addition, computing skills are increasingly valued across a range of academic disciplines and occupations, spurring demand for courses even among those who don't wish to major in the field.

The boom is leaving many departments and universities struggling with how to meet student demand for classes. Hiring and retaining enough faculty to teach them has been a particular problem. The majority of new Ph.D.s take jobs in industry, and opportunities in academia may not look as appealing: The funding situation in many departments is tight and uncertain, the classes that must be taught are large, and maintaining a balance between building a research program and meeting teaching obligations can be

challenging. Many departments face constraints not only on faculty but also on classroom and lab space and administrative support.

A new report from the National Academies says U.S. colleges and universities should take urgent steps to deal with these challenges and respond to rising computer science enrollments. The report examines the benefits and drawbacks of a range of strategies that institutions could pursue — for example, adding resources and faculty, limiting the number of students allowed to enroll in programs, or using innovative technologies to deliver instruction to large numbers of students.

There is no one-size-fits-all answer, the report says. Each institution needs to select strategies and make trade-offs that are appropriate to their mission and values. But all institutions should assess the role of computer science and computing and make strategic plans, thinking long term and considering the role of computing institution-wide.

As part of this planning, college and university leaders should work with their computer science departments to develop appropriate targets for faculty size and strategies for hiring and retaining faculty, the report says. Partnerships with the computing industry could allow a better exchange of Ph.D.-level researchers between academia and industry, as well as help ensure that departments continue to graduate students who are well-prepared to meet workforce needs.

As institutions begin to respond to growing enrollments, they should monitor how their actions affect the diversity of their

student body in computer science — currently one of the least diverse disciplines, the report notes. Colleges and universities should leverage growing student interest in computing as an opportunity to recruit more women and underrepresented minorities into the field. And they should align their actions and the culture of their programs with best practices for supporting diversity and retaining students.

While some institutions may view imposing limits on enrollment in computer science programs and courses as desirable or inevitable, they should carefully consider the consequences before doing so, the report cautions. Such limits may cut students off from their true passion, and they may introduce an environment of real or perceived competition among students who desire to enter a program, which could discourage participation among underrepresented groups. At the same time, institutions should not accept students with the promise of entering a major when limited resources make their admission into the program unlikely. — *Sara Frueh*

Assessing and Responding to the Growth of Computer Science Undergraduate Enrollments (2017, approx. 184 pp., ISBN 978-0-309-46702-5) is available from the National Academies Press, tel. 1-800-624-6242; \$70.00 plus \$6.50 for single copies; also on the Internet at <www.nap.edu/catalog/24926>. The study, which was sponsored by the National Science Foundation, was co-chaired by Susanne Hambrusch, professor of computer science at Purdue University, West Lafayette, Indiana; and Jared Cohon, president emeritus and University Professor of Engineering at Carnegie Mellon University, Pittsburgh.

LabX

BRINGS SCIENCE TO THE PEOPLE

The National Academy of Sciences has launched LabX, a new public engagement program to promote evidence-based decision-making on issues that have significant relevance to individuals and communities and in which science is an important factor. The program's plan is to engage audiences — young adults, in particular — through a combination of online platforms and face-to-face group activities at venues in Washington, D.C., and at other locations around the country. Its first event,

Night Lab: Hackology, took place March 7 and featured team trivia, group activities, and photo challenges.

"In today's world where the boundary between science and science fiction is hard to discern, it is too easy to forget the very real way that science and technology are — and should be — applied to make meaningful

differences in our lives," said NAS President Marcia McNutt. "LabX engages citizens in the application of science to community decision-making to promote resilience, improve safety and security, and achieve any number of other desirable outcomes."

The LabX program will build upon the work of the Academy's Koshland Science Museum, which closed in November 2017, and will continue the museum's mission of inspiring people to use science to solve problems in their communities. One model for such engagement is the Extreme Event role-playing game, which was developed by the museum in collaboration with the National Academies' Resilient America Roundtable and focuses on disaster resilience. The game has been played in more than 40 cities across the U.S., Europe, and Asia by a variety of community and educational groups supporting preparedness.

LabX is supported by the generous gift from the late NAS member Daniel E. Koshland Jr. that established the Koshland Science Museum in memory of his wife, Marian E. Koshland, also an NAS member. The NAS is grateful for his generosity, for the ongoing support of the Koshland family, and for NAS members' involvement in the evolution and expansion of public engagement with science.

"The Koshland family is excited about the change and supports of the direction of LabX," said Gail Koshland, daughter of Daniel and Marian. "LabX will continue to focus on the fundamental principles on which the Koshland Science Museum was established to develop rich, immersive experiences related to issues in everyday life."

— *Molly Galvin*

Visit the program's website at labx.org.



New Academies Initiatives Take On Environmental Health Matters and Climate-Related Issues

The National Academies of Sciences, Engineering, and Medicine are launching two major initiatives to more effectively enable their extensive body of work on climate and environmental health matters to inform the public and decision-makers.

Let's Talk About Climate Change

All branches of the National Academies explore issues related to climate change. In addition to examining new frontiers in climate science, the Academies have studied climate impacts on national security, agriculture and food

innovations in energy, vehicles, and carbon removal; and social and behavioral sciences dimensions of environmental change.

"The National Academies have a vast library of authoritative information to help everyone from savvy citizens to responsible decision-makers understand, prepare, and respond to climate change," said Marcia McNutt, president of the U.S. National Academy of Sciences. "This initiative facilitates access to that storehouse to help protect the many sectors of human investment from unnecessary surprises."

The Climate Communications Initiative aims to coordinate efforts across the Academies to successfully address public questions about climate change, develop

innovative approaches for communicating and disseminating climate information to military, corporate, and civic leaders so that they can responsibly lead their organizations and communities, and provide easy access to evidence-based findings and explanations of climate change to various audiences.

A multidisciplinary advisory committee has been appointed to develop a strategic plan for the initiative and also provide guidance in implementing the plan. The group will be led by David



security, extreme weather events, coastal communities affected by sea-level rise, transportation infrastructure, community resilience, ecosystems, and human health; new

Titely, former rear admiral in the U.S. Navy and a professor of practice in meteorology and founding director of the Center for Solutions to Weather and Climate Risk at Pennsylvania State University. Members of the committee bring a diverse set of expertise in climate science, climate impacts and economics, potential response options, science communication, social media engagement, and science education, and represent a variety of different sectors and stakeholders, including government, industry, communications, and academia.

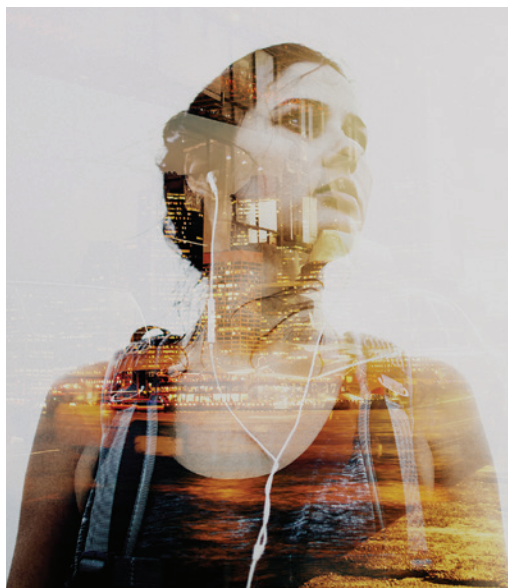
Untangling the Complicated Connections Between Environment and Health

The Academies have also embarked on another institution-wide initiative to transform how the nation addresses the complex issues associated with environmental health — a field of science and public health practice that examines how the environment

affects human health. This effort will bring together expertise across the institution, including environmental, medical, and social science, energy, and engineering, and involve leaders from government, corporate, and academic entities to explore the latest science, identify promising solutions, and create innovative pathways toward improving environmental health.

Through the Environmental Health Matters Initiative, the Academies will provide leadership by convening and facilitating efforts to identify environmental health's big questions, explore their complexity, enable the development of holistic and sustainable options, and provide rapid expert input when crises demand.

Here, too, the Academies have appointed a multidisciplinary committee to steer the initiative and its endeavors in advising the nation on environmental health issues and creating outreach mechanisms to enable a broader range of stakeholders to engage and use the breadth of relevant work. The committee will be chaired by Thomas Burke, Jacob I. and Irene B. Fabrikant Professor and chair in health risk and society at Johns Hopkins Bloomberg School of Public Health. — *Riya V. Anandwala*



For more information, visit the initiatives' websites at nas.edu/climate/ccl and www.nas-sites.org/envirohealthmatters.

Moving the Economy of the Future

HIGHLIGHTS FROM TRB'S 97TH ANNUAL MEETING

Policymakers, administrators, practitioners, researchers, students, journalists, and representatives of government, industry, and academic institutions gathered in Washington, D.C., in early January for the Transportation Research Board's 97th Annual Meeting. A record number of attendees, over 13,700 in all, took in more than 5,000 presentations, sessions, and workshops over the course of five days.

This year's spotlight theme was "Transportation: Moving the Economy of the Future."

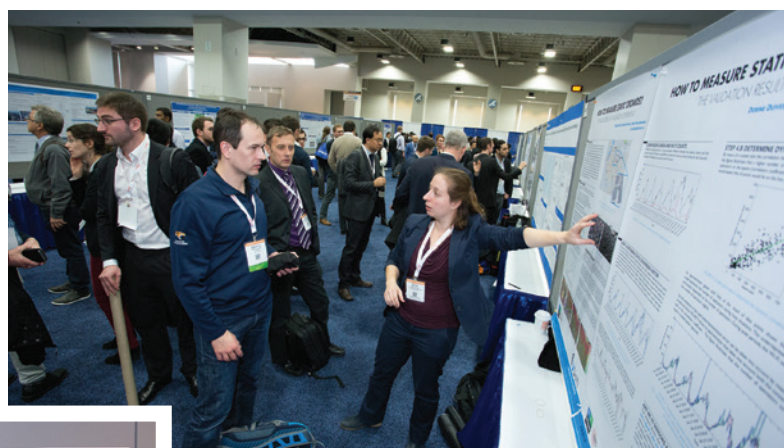
Fifty sessions focused on this broad theme, encompassing topics like multimodal opportunities and challenges of bringing food from farms to tables, the U.S. Department of Transportation's "Mobility on Demand" initiative, narrowing social disparities in cities, and how and when to use private money for transportation infrastructure projects. During the meeting, TRB made



it a priority to raise awareness about diversity in transportation, with TRB Executive Director Neil Pedersen signing a Memorandum of Understanding (MOU) with both the Council of Minority Transportation Officials and the Women's Transportation Seminar. Each MOU provides a framework for further diversifying the transportation profession through professional development activities, information sharing, and more. In addition, a group of 21 students from 14 schools were named to TRB's Minority Student Fellows Program. Founded in 2010, the Fellows Program is one way TRB illustrates its commitment to diversity, enabling minority students to attend the annual meeting, present their research, and network with transportation professionals.

The keynote address of the Chairman's Luncheon centered on the transportation of the future. Given by James Ray, senior adviser for infrastructure to Transportation Secretary Elaine Chao, the speech was





accompanied by a clip from Disney's "Magic Highway," a 1958 sci-fi take on the future of transportation, featuring digital highway signs, traffic alerts, rearview cameras, and more. Ray stressed before an audience of approximately 800 that "new, connected, automated and electric transportation technologies are transforming our world and altering the ways businesses and industries operate, affecting every aspect of our lives," leading us toward "living in a time when the science fiction we grew up with is becoming reality."

TRB's incoming officers, new minority student fellows, and numerous award winners were honored at the Chairman's Luncheon. Katie Turnbull, professor and executive associate director of Texas A&M Transportation Institute, commenced her term as the new chair of TRB's Executive Committee. An expert on transportation planning and intelligent transportation systems and a veteran of multiple TRB

report and planning committees, Turnbull has been associated with TRB since 1993, having most recently served as vice chair of the Executive Committee. Succeeding Turnbull as vice chair is Victoria Arroyo, the current executive director of the Georgetown Climate Center here in Washington, D.C.

TRB hosted its first-ever Careers in Motion Networking Fair on the first day of the meeting. Hundreds of attendees, largely students and young professionals, took advantage of the opportunity to meet with prospective employers, get their resumes critiqued, and attend presentations on a range of helpful job search-related topics. Another meeting first was the showcasing of a prototype for a fully autonomous freight vehicle from Swedish company Einride in the TRB Exhibit Hall, which drew large and curious crowds.

While the world's largest gathering of transportation professionals generated news headlines on everything from truckers' pay and infrastructure upgrades for ports, to the effects of millennials' purchasing habits on shipping and using data to predict the risk of crashes, TRB is already looking forward to the 98th Annual Meeting, set for next January in Washington, D.C. — *Josh Blatt*

National Academies to Serve as IAP-R Secretariat

The National Academies of Sciences, Engineering, and Medicine are now serving as the host for the InterAcademy Partnership for Research (IAP-R) secretariat. The IAP-R is the research advisory arm of the InterAcademy Partnership, an organization of more than 130 national and regional academies of science, engineering, and medicine around the world.

IAP-R, formerly known as the InterAcademy Council, enlists pre-eminent scientists and engineers worldwide to provide high-quality, in-depth scientific advice to the United Nations, other international organizations, and national governments on critical science policy issues. IAP-R's studies, which are conducted using expert committees and independent peer review, have included a review of the work of the U.N.'s Intergovernmental Panel on Climate Change (IPCC) and the development of a global guide on the responsible conduct of scientific research.

Currently there are two IAP-R studies in progress — one that is identifying

ways to improve scientific input to global policymaking in order to help attain the Sustainable Development Goals set by the United Nations, and another examining how best to harness science, engineering, and medicine to address challenges in Africa.

"We believe that it is more important than ever for the U.S. scientific community to maintain and strengthen its alliances with researchers around the world, including through partnerships with scientific academies," said NAS President Marcia McNutt. "At no time in history has science advice to governments been more necessary; thus, we are committed to collaborating on the development of global mechanisms to provide sound advice to the international community on cross-border issues that affect us all."

Under a memorandum of understanding, the National Academies will host and staff the IAP-R secretariat for up to the next five years. Teresa Stoepler of the Academies' Policy and Global Affairs Division has been selected as IAP-R's executive director.

— Sara Frueh



Harnessing Science to Help Refugees

An estimated 65 million people around the world have been displaced in the wake of violence and conflict, driven from their homes and in many cases their countries. What role can scientists, engineers, and health professionals play in supporting refugees' well-being and human rights? And how can they help their colleagues who have been displaced? In December the National Academies' Committee on Human Rights held a symposium to explore these questions.

In his keynote address, former United Nations Deputy High Commissioner for Refugees Alexander Aleinikoff explained that one of the biggest challenges is the protracted nature of many refugee crises. People are often displaced for decades, able neither to return home nor to fully participate in life in their new location. Some of the panel discussions that followed delved

into how technology can help respond to challenges linked to displacement, including helping refugees more fully participate in their new countries. An organization called PeaceGeeks, for example, is developing an app for newcomers arriving in Canada to help them identify the services they need — such as support in finding employment or a school for their children, or for learning English — and develop a personalized





road map to connect them with those services.

The symposium highlighted another key way in which scientists, engineers, and health professionals can respond to refugee crises: through research, which in some cases has already helped to guide decisions by governments and humanitarian organizations. “Data can be a powerful tool when designing interventions and formulating policy, particularly given resource limitations and competing priorities,” said Martin Chalfie, chair of the Committee on Human Rights, who echoed other speakers in pointing to the need for more rigorous evidence-gathering and analysis. Evidence-based approaches to displacement should go hand in hand with policies and interventions that acknowledge and respect human rights, he stressed.

Presentations also looked at other ways for scientists, engineers, and health professionals to help their displaced colleagues, for example by supporting the efforts of Scholars at Risk, the Scholar Rescue Fund, and other organizations dedicated to helping displaced scholars find safe places



to continue their work. In addition, the symposium featured a screening of “Science in Exile,” a documentary that explores how recent conflict in Syria, Yemen, and Iraq has threatened the lives and livelihoods of researchers, forcing them to suspend their work and flee their homelands. A trailer and information on the film can be found on the website of the World Academy of Sciences at <twas.org/article/journey-refugee-scientists>. — *Sara Frueh*

More information on the symposium and an archived webcast of presentations can be found at www7.nationalacademies.org/humanrights/.



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Painting by artist Albert Herter, photographed by Mark Finkstaedt

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