International Science Reserve
Powered by the New York Academy of Sciences

Preparing for Crisis:

Lessons from the International Science Reserve Stage One Research and Development

Authors:

Stephen D. Albright
Jill Fromewick
Benjamin Young
Chenelle Bonavito Martinez
Mila Rosenthal

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COVER: A group of Very Large Array radio telescopes in New Mexico, USA.
Credit: dscz / E+ via Getty Images

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Preface

As the gloomy donkey Eeyore in A. A. Milne's children's classic Winnie-the-Pooh *observed, "Accidents. You never have them till you're having them."*

The lesson behind Eeyore's remark is "be more careful"—understand that accidents, and disasters, are by their nature unpredictable and inevitable. We should do all we can to prevent them. But when they happen, we should be prepared to react. We should listen to Eeyore.

Crises can emerge suddenly and escalate quickly—such as the current coronavirus pandemic—or emerge slowly but then accelerate alarmingly—such as the effects of human-caused climate disruption. Increasingly sophisticated systems for identifying global risks and predicting large-scale crises warn us how important it is to turn shrugging acceptance that accidents will happen into decisive preparation.

The International Science Reserve (ISR) aims to help with decisive preparation. Global risk assessments tend to identify the same potential crises: climate impact hazards such as floods, droughts, and collapsing supplies of food and water; digital threats and cyberattacks; and ever-more-deadly pandemics. The ISR draws its purpose from the recognition that in all these emergencies, the human impact is usually uneven: falling most heavily on people and communities who are poor and have the least power. The United Nations 2030 Sustainable Development Goals, a global blueprint for a better shared future, reflects the principle that no one should be left behind. The ISR shares this commitment to making sure our work protects and benefits everyone.

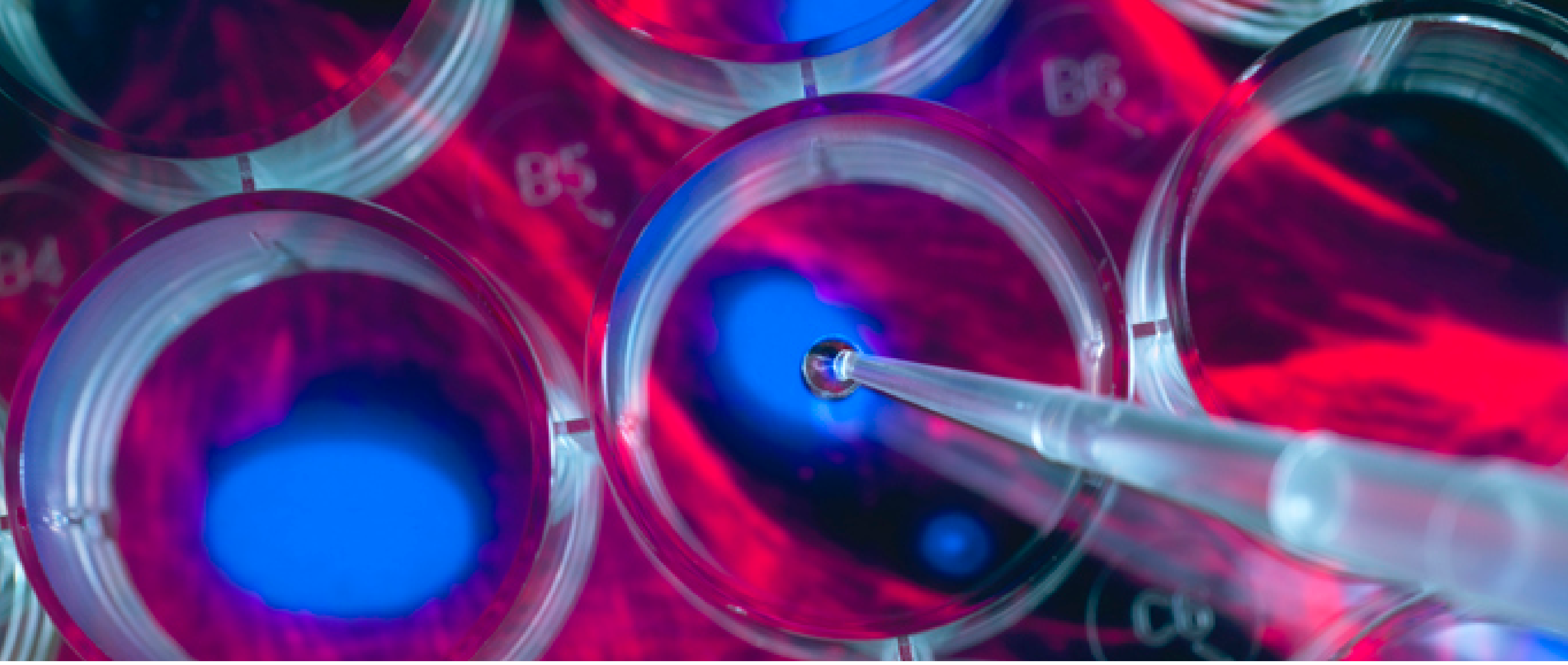
In each anticipated crisis, cutting-edge scientific research and technology will be crucial to marshalling an effective, purposeful response, to help protect people and ecosystems, and help communities recover from disasters.

Existing systems and organizations for crisis response are not sufficient to meet all needs, nor do they fully leverage scientific and technological knowledge, expertise, and labor. That's where the New York Academy of Sciences and our partners can play an important role. Since we already know these kinds of emergencies will happen, we resolved to put ingenuity and effort into preparing to handle them better. We have identified gaps in crisis responses that the ISR intends to fill.

By design, the ISR is about helping scientists think creatively about how they can best apply their expertise to different emergencies. The ISR will also prepare and position scientific resources in advance. All of this preparation should mean that scientists can craft better scientific solutions when disasters strike. This white paper is a first step in our exploration of the ISR's potential to improve the direct impact of science and technology in times of need.

In Winnie-the-Pooh, *despite Eeyore's warning to be careful, Piglet nearly drowns in a flood. Pooh makes an umbrella into a boat to save him. It's a great response to a sudden crisis: a technological innovation, created on the spot.*

Mila Rosenthal
Executive Director, International Science Reserve
June 2022



ABOVE: Scientist pipetting cells into a multi well plate.
Credit: Andrew Brookes / Image Source via Getty Images

00 Executive Summary

The International Science Reserve (ISR), an initiative of the New York Academy of Sciences, was created in 2021 to research and develop a model to help researchers around the world improve their preparation for and response to global crises by identifying and pre-positioning scientific, technical, and human resources.

The ISR seeks to:

- Identify gaps where current crisis response processes could be strengthened by additional scientific research;
- Mobilize scientists to address those unmet needs;
- Identify scientific and technological resources essential to crisis response and facilitate scientists' access to them; and
- Increase scientific preparedness for crises that span national borders, where there may be barriers to the quick flow of scientific information.

The ISR was informed, in part, by the unprecedented response to the COVID-19 pandemic, resulting in the quick development of COVID-19 vaccines and treatments. This was made possible through the collaboration of academia, industry, governments, non-governmental organizations, and scientists around the world. The ISR seeks to ensure that collaborative systems and shared resources, like the ones that were mobilized in response to the pandemic, are assembled and ready before the next complex global crisis strikes.

In its first year of operation, the ISR established a network of over 1,000 interested scientists in over 90 countries, and staged its first Crisis Readiness Exercise. This centered on wildfire scenarios in three countries: the United States, Greece, and Indonesia.

The exercise in March, 2022, included both a discussion-based test—a facilitated workshop with key ISR stakeholders—and an operations-based test, a simulation of an ISR crisis response. The simulation consisted of the solicitation and evaluation of research proposals, including a selection of necessary resources. The tests were based on a mock request for proposals (RFP) to address a simulated wildfire crisis. Eighteen submissions that expert reviewers deemed actionable were received from nine countries: Australia, Brazil, Chile, Kenya, Peru, the Philippines, Trinidad & Tobago, Turkey, and the United States.

The exercise allowed both participating scientists and the ISR to think about goals, processes, and needs in times of crisis—without the pressures of a real emergency. Scientists from around the world had the opportunity to outline potential projects, consider the tools they would need to carry out their research, and familiarize themselves with the proposal submission procedure. The ISR, in turn, was able to begin testing its processes and identify areas for development or improvement.

The exercise, and the preparatory work that led to it, highlighted both the potential of the ISR and the strength of its mission, and some of the challenges that must be overcome. Findings include:

- Many scientists want to join interdisciplinary communities focused on crisis response;

- It may often take iterative, user-centered design to develop scientific readiness exercises to engage scientists before crises occur;

- Consensus may be achievable among scientists and crisis response experts regarding which resources are needed to address a particular crisis. However, identifying resources that will be valuable across different types of crisis may take more deliberation.

The ISR is committed to building on the achievements of its first year, and exploring additional crisis readiness scenarios. Our experience with the first readiness exercise has demonstrated that ongoing development and practice can help empower scientists to act when action is needed.

ABOVE: A woman in a field with wind turbines.
Credit: Unshu / Adobe Stock

01 Introduction

What can science uniquely offer in a time of crisis? How is scientific research during a crisis different—or in what ways should it be different—from science as usual? And what do scientists need to effectively contribute to crisis preparation, response, and recovery? These are questions that guided the development of a new initiative to test a crisis response model to improve the mobilization of scientific resources: the International Science Reserve (ISR), powered by the New York Academy of Sciences.

Because the ISR is testing its model in the spirit of R&D for the public good, the New York Academy of Sciences is committed to "working out loud" by publicly sharing insights from the process and outcomes of the ISR's development. In that vein, this white paper constitutes our first public report, to the scientific and crisis response communities, as well as anyone who is interested in the role science plays during crisis.

In the pages that follow, we present our primary hypotheses, learnings, and emerging questions from the ISR's initial year of activity. The research documented in this paper will shape the ISR's operating model, and we hope it may also spark insights or paths of inquiry for others interested in the problems, gaps, and opportunities for science in a time of crisis.

Why the ISR?

The rapid response to the COVID-19 pandemic made clear the important role of science in responding to global crises.

The unprecedented development of COVID-19 vaccines and treatments—within a year of outbreak—was made possible through the collaboration of academia, industry, governments, non-governmental organizations, and scientists around the world. This demonstrated how science can be mobilized quickly for public good.

However, while the scientific response to the pandemic accomplished major successes, there were shortfalls. Scientists were not able to break political and policy barriers to secure sufficient funding *before* the pandemic to meet the threat as aggressively as possible when SARS-CoV-2 struck in full force. Institutionalized bias in research and medicine prevented fully-successful public health measures across all populations. National policies prevented equitable distribution of vaccines and therapies around the globe. If the science community had been better primed for action at the outbreak of the pandemic, the virus might have been contained at its earliest stages. Lives might have been saved and many disruptions to society might have been prevented.

The ISR was founded on the simple idea that scientists make important contributions to solutions to global crises but that current systems and organizations for crisis response do not fully leverage their potential. The ISR seeks to improve scientific crisis response through earlier planning and the assembly of resources that scientists can quickly tap.

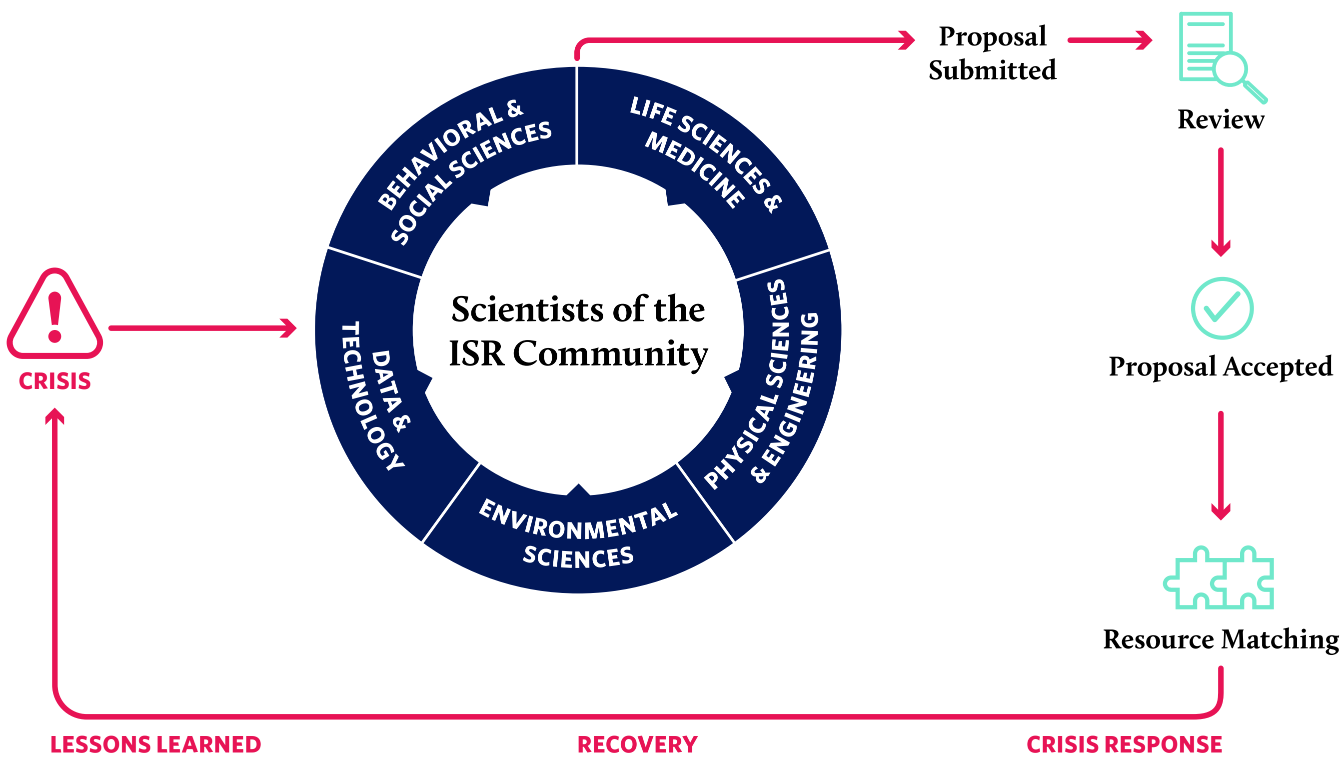
Within a crowded field of organizations addressing varied crises using a myriad of approaches, the ISR seeks to contribute something novel and of value by centering on three main goals. The ISR will:

- Mobilize scientists around the globe to contribute to the work of existing response efforts;
- Facilitate scientists' access to resources to enable or accelerate their crisis-related work, through a network of public and private partners; and
- Focus on cross-border crises where there may be political barriers to the rapid exchange of scientific information and data.

"We are scientists. We have no nations. It is crucial for us to collaborate across international borders, through organizations like the International Science Reserve. My hope is that the global scientific community will be able to solve some issues that cannot be solved on a national level."

Fulya Aydin-Kandemir,
Participant in the ISR Wildfire Readiness Exercise
Hydropolitics Association & Adeniz University, Turkey

The ISR took inspiration from one specific contribution to the collaborative global response to the COVID-19 pandemic. This was the COVID-19 High Performance Computing (HPC) Consortium, a private-public collaboration initiated by the White House Office of Science and Technology Policy, the U.S. Department of Energy, and IBM that gave scientists rapid access to cutting-edge computing resources. The Consortium greatly accelerated COVID-19 research.



One essential component of the ISR's model is a similar matching of scientists to resource providers. The ISR, however, seeks to extend this matchmaking of people and resources beyond high performance computing, and to a broad range of crises.

Additionally, the ISR is testing the proposition that scientific networks, like the ones that sprang up to respond to the pandemic, can be even more effective if they are assembled and ready before the next crisis strikes.

Finally, the ISR model aims to prepare for novel, complex crises that have impact across national borders—ones that exceed any particular country's scientific capabilities and that require global co-operation.

Our aim is to put scientists and a wide range of resource providers in a stronger position to respond to these as-yet-unknown, fast-moving, transnational crises, by:

- Building a diverse, international community of scientists that stands ready to address various crises;
- Calling on the community to submit research proposals and requests for resources once crises strike; and
- Quickly matching and allocating resources to jump-start or accelerate promising projects.

Central to the ISR's model are readiness exercises, resource planning, and resource allocation to support scientists.

For its first readiness exercise, the ISR selected wildfires and consulted with experts to develop geographically-dispersed crisis scenarios. A goal was to draw the interest of a broad range of scientists among the wildfire research community as well from scientists in other fields who believe interdisciplinary perspectives can identity problems and contribute to their solutions.

The ISR's exercise sought to both prepare scientists to respond to crisis and test the ISR's model for response. Scientists from around the globe were recruited to join the ISR Science Community and then were invited to take part in a crisis simulation by developing projects that addressed a wildfire crisis scenario. Since one of the ISR's core functions in a time of crisis will be to match projects with supporting resources, scientists taking part in the readiness exercise had the opportunity to specify resources they would need to carry out their proposed research, either by selecting from items identified by wildfire experts or by describing their own specialized needs.

The ISR's first readiness exercise was an occasion for both scientists and the ISR to think about processes and needs in times of crisis—without the pressures of an actual emergency. Participating international scientists also familiarized themselves with the proposal submission procedure. Additionally, the ISR was able to begin testing its processes and identify areas for development or improvement.

While this is very much still the beginning of a journey for the ISR, its members, and its partners, the response has already been strong: today, the ISR Community includes over 1,000 members from more than 90 countries, across various scientific fields of research. It is our hope that the learnings from our first readiness exercise and our first year of planning can serve not only to help the ISR forge a path forward but also be of value to this core community and, through its work, to the people whose dignity, health, safety, and prosperity are affected by the next crisis.

"An aspect that is still missing in the field of paleoecology, especially in developing countries, is the use of paleoecological data to address present-day ecological challenges. Participating in the ISR wildfire readiness exercise was a way for me to expand my research impact. I want my research to help people, to contribute to humanity, because directly or indirectly ecological crises affect people's lives."

Matthew Adeleye
Participant in the ISR Wildfire Readiness Exercise
The Australian National University, Australia

ABOVE: Two scientists in a lab perform analysis using mass spectrometry.
Credit: SolStock / E+ via Getty Images

02 The ISR Science Community

Building the Science Community

To recruit scientists and engage them in readiness activities, marketing and communications activities were integrated into ISR research, testing, and community building.

ISR's early steps included establishing unique and identifiable branding and the creation of short, shareable social media videos to introduce the ISR and its methods. These targeted scientific communities around the world. Additionally, the ISR sought media coverage, resulting in articles in Fortune[1] and Axios[2] news websites. The ISR also presented the ISR model to strategic collaborators, such as the Council of Scientific Society Presidents[3] and the Aspen Ideas Festival.[4]

These efforts built general awareness of the ISR within the scientific community, laying the foundation for a second stage of more targeted recruitment around the ISR's first crisis readiness exercise, focusing on wildfires.

[1] David Meyer, " Meet the International Science Reserve, the IBM-led project to prepare the world for future catastrophes," Fortune, September 29, 2021, https://fortune.com/2021/09/29/international-science-reserve-ibm-nyas-climate-disasters-covid-pandemics/.

[2] Alison Snyder, "Guarding against the next pandemic with a LinkedIn for science," Axios, July 15, 2021, https://www.axios.com/2021/07/15/guarding-against-the-next-pandemic-with-a-linkedin-for-science.

[3] https://www.sciencepresidents.org/2021-winter-leadership-workshop

[4] https://www.aspenideas.org/sessions/accelerating-discovery

SCIENTIST RECRUITMENT

The ISR team organized a series of scoping interviews with wildfire experts from government research and response agencies in the United States and Canada including the U.S. Forest Service, the Canadian Forest Service, and the British Columbia Centre for Disease Control. These authorities identified a wide range of scientific disciplines for the ISR to target in recruitment, ranging from fire science to environmental science, engineering, and the behavioral sciences. The experts also provided explanations for how various types of responders and scientists approach wildfire crises, and the resources they need for crisis response.

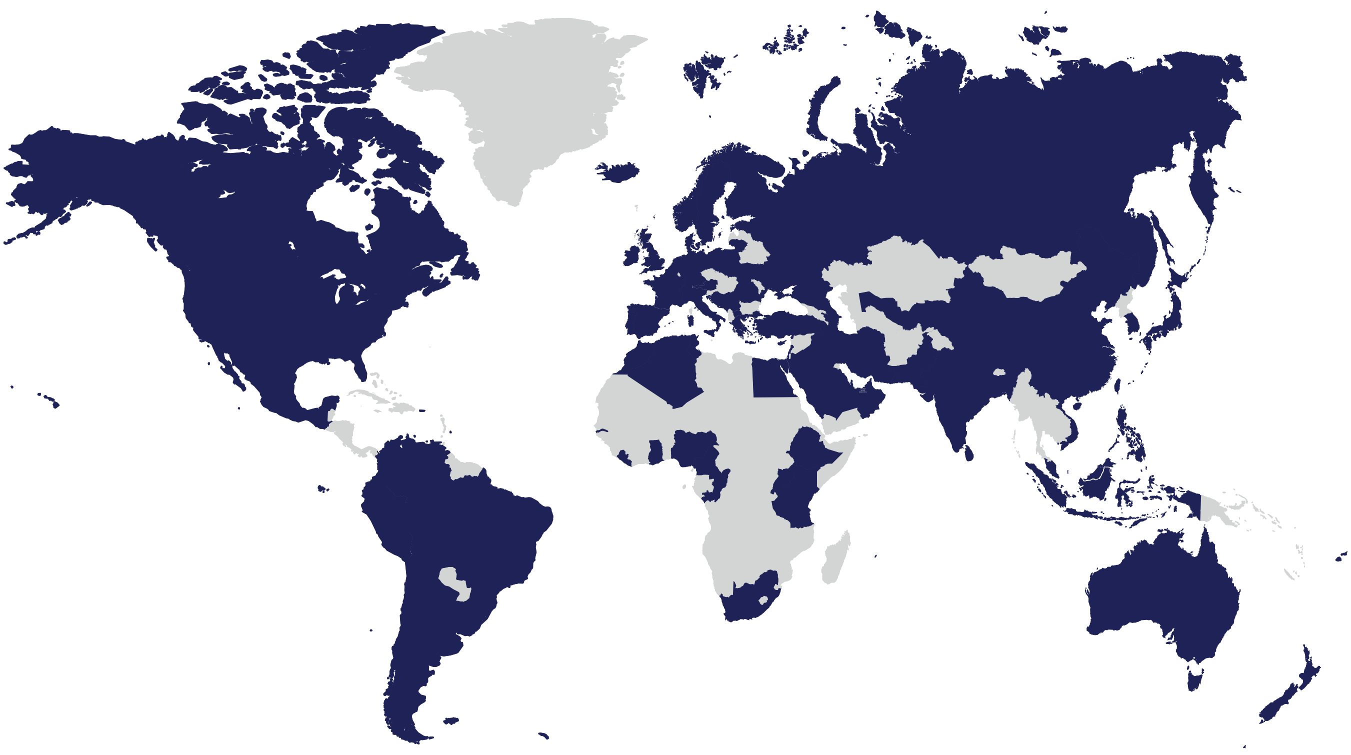
To focus recruitment efforts and reach specialized scientists more directly for wildfire crisis readiness, the ISR organized scientists into three groups:

- Scientists working directly in wildfire research;
- Researchers working in fields adjacent to wildfire research, including ecology, meteorology, climate change, and forestry; and
- Engineers, data scientists, social scientists, and others, whose expertise can be tapped to contribute to the crisis response.

To leverage the existing New York Academy of Sciences network, we conducted a phased recruitment. Various channels were used to recruit scientists, including:

- Connecting with the Academy's existing scientific network of over 140,000 scientists and administrators in academia, government, and industry; policy experts; and leaders of non-governmental organizations;
- Extending collaborative relationships, such as with the Council of Scientific Society Presidents; and
- Partnering with key wildfire-related organizations, including UL and research stations of the U.S. Forest Service, to introduce the ISR to their networks.

The ISR also utilized a publication database to identify researchers in disciplines and geographic regions not yet represented in the ISR Community. This iterative recruitment approach allowed the ISR to fill gaps and curate a diverse, international Science Community to test preparedness for response to a wildfire crisis.



Countries represented in the ISR Science Community

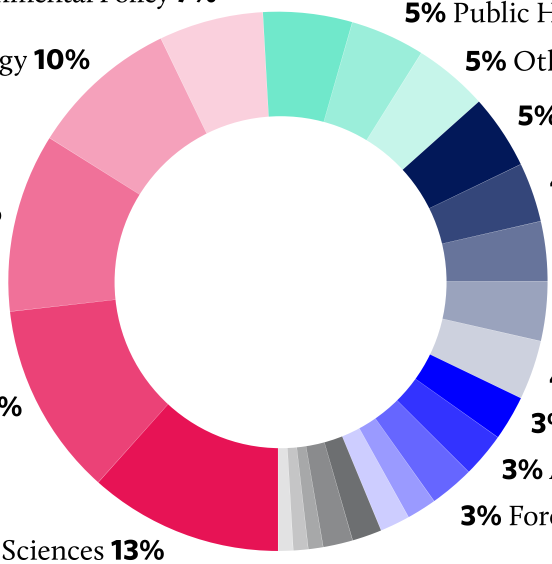
Our Initial Community

After a two-month recruitment effort, the Science Community consisted of over 1,060 members from 92 countries. The countries most represented were Australia, Brazil, India, Nigeria, Turkey, and the United States. Membership included over 400 scientists in the first two scientific domain groups—researchers in wildfire science and in adjacent fields—demonstrating that the ISR's recruitment approach was successful in reaching scientists with specific expertise in wildfires. Outside of wildfire research, Science Community members came from disciplines that include the physical sciences, engineering, data science, the life sciences, medicine, and behavioral science.

COMMUNITY SURVEY

The ISR collected more detailed information about its Science Community by inviting new members to complete a survey. 670 community members completed the survey. More than half the scientists had conducted wildfire research, and of this subset, 82% said that their research was cross-disciplinary. Of note, 86% of scientists with no wildfire research experience were interested in collaborating on future wildfire crises, supporting the ISR’s goal of harnessing cross-disciplinary research to address future crises.

Beyond the ISR's successful recruitment of a diverse and international Science Community interested in participating in cross-disciplinary responses to wildfires, 70% of the scientists who had already contributed to wildfire research stated that access to listed resources would accelerate their research. This supports the validity of the ISR model of facilitating resource access in times of crisis to advance research outcomes.



Scientific disciplines represented in the ISR Science Community

ABOVE: A woman tests soil health in Western Kenya, Africa.
Credit: © 2016 CIAT / Georgina Smith

03 Wildfire Readiness Exercise

Preparing for Crisis

While readiness exercises are an established method for preparing for crisis response, they are conventionally focused on preparing first responders and local authorities, rather than scientists and scientific resources, for rapid deployment.

The ISR, instead, used its first readiness exercises for more open-ended and exploratory purposes, to learn:

- How scientists might contribute to and support established, conventional first response activities;
- How scientists might address longer-term consequences—beyond initial crisis response;
- What resources are conventionally used by first responders;
- Which of these resources might be of value to members of the ISR Science Community;
- What additional resources might ISR scientists need;
- Whether resources must always remain crisis-specific, or whether resources might transcend different types of crisis.

For the Wildfire Readiness Exercise, the ISR adopted both a discussion-based test and an operations-based test. In discussion-based exercises, facilitators lead discussions that help participants understand or develop new roles, procedures, and plans. Operations-based exercises use scenarios to mirror realistic situations and ask participants to engage in "real-time response," e.g., mobilizing personnel.[5-7]

The ISR's operations-based testing focused on a mock Request for Proposals (RFP) to address a simulated wildfire crisis.

[5] Emma E.H. Doyle, Douglas Paton, & David M. Johnston, "Enhancing scientific response in a crisis: Evidence-based approaches from emergency management in New Zealand," Journal of Applied Volcanology 4, (January 16, 2015): 1, https://doi.org/10.1186/s13617-014-0020-8.

[6] Karin Reddin, Henry Bang, & Lee Miles, " Evaluating simulations as preparation for health crises like CoVID-19: Insights on incorporating simulation exercises for effective response," International Journal of Disaster Risk Reduction 59 (June 1, 2021): 102245, https://doi.org/10.1016/j.ijdrr.2021.102245.

[7] "Homeland Security Exercise and Evaluation Program," FEMA.gov, https://www.fema.gov/emergency-managers/national-preparedness/exercises/hseep.

Developing the Request for Proposals

To construct the mock RFP, the ISR team gathered information from a series of interviews with wildfire experts. These included landscape interviews to understand wildfire science as a whole, direct consultation regarding wildfire scenarios, an internal literature review of global wildfire crises, and the survey of ISR community members. This research led to the three wildfire crisis scenarios and a list of resources that could be deployed in any of the three scenarios to support research concepts solicited in the mock RFP.

WILDFIRE CRISIS SCENARIOS

Prior to testing, wildfires were chosen to represent fast-moving crises that are likely to occur, have potential transnational impacts, and for which science and technology can play major roles in addressing.

The ISR team developed these scenarios based on internal research and in consultation with experts, including Dr. Sara Brown and Dr. Karin Riley of the U.S. Forest Service, and Dr. Erica Fischer from Oregon State University. Dr. Brown and Dr. Riley are experts in climate and fire ecology. Dr. Fischer is a civil and construction engineer who specializes in the resilience of structural systems affected by natural and man-made hazards, including fires.

The three scenarios selected were:

- A crown fire in the conifer forests of the Northwestern United States;
- A rapidly moving brush fire in Greece; and
- A slow burning peatland fire in Indonesia.

At the recommendation of the consulting experts, the ISR team developed three independent scenarios to maximize engagement with scientists from a wide range of disciplines. The full text for each scenario can be found in Appendix 1.

"As scientists, we can prevent real crises. I participated in the ISR Readiness Exercise because this type of exercise makes our research matter by allowing us to think in advance, think about the future. When a crisis arrives, we can have strong projects or concepts that are ready to help mitigate disasters."

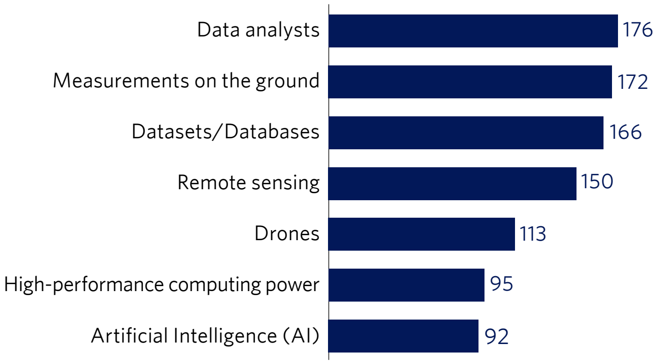
Roberto Dias
Participant in the ISR Wildfire Readiness Exercise
Scientific Director of Microbiotec, Fundação Arthur Bernardes/ Petrobras, Universidade Federal de Viçosa, Brazil

RESOURCES

In a crisis, a core function of the ISR will be to match resources to projects. For the readiness exercise, the ISR developed a list of resources that could be applied to respond to a wildfire crisis and instructed scientists responding to the RFP to identify which of these resources they would utilize.

The ISR team grouped resources into several broad categories, which we believed would give scientists the flexibility to think creatively about the resources they may need. However, active deployment of the ISR will rely on offering several specific resources (such as time on an HPC platform or access to a particular wet lab). The full list of resources offered can be found in Appendix 2.

Resources that survey responders identified as needed in wildfire crisis response (n=262)



Discussion-based Testing

Both the discussion-based and operations-based tests that constituted the Wildfire Readiness Exercise began the week of March 21, 2022. For the discussion-based test, the ISR facilitated a Crisis Response Workshop with a small group of high-level stakeholders with relevant expertise in the fields of governmental crisis response, crisis resource distribution, and international policy. The workshop's goal was to share knowledge on how resource providers respond in a real trans-national crisis using the wildfire scenarios as a starting point for discussion.

Participants identified several challenges to distributing resources in the time of crisis, including:

- Distributing resources to and performing research in countries without strong pre-existing relationships;
- Navigating intellectual property and other guarded data in developing and accessing software, datasets, and other technologies; and
- Determining which resources can be assembled to address multiple types of crises.

The question of whether generalizable resources exist must shape how the ISR prepares scientists and resource providers for crises. If there are resources that can be used in different kinds of wildfire crises (such as crown fires and peat fires), or across different types of crises (such as wildfires and water-borne pathogens), resources can be pre-positioned. However, if the resources are crisis-specific, it would be necessary to rapidly develop agreements with resource providers after a crisis occurs. Participants did not come to a clear consensus regarding whether the resources offered in the Wildfire Readiness Exercise were generalizable across the three wildfire scenarios, or to other types of crisis.

Operations-based Testing

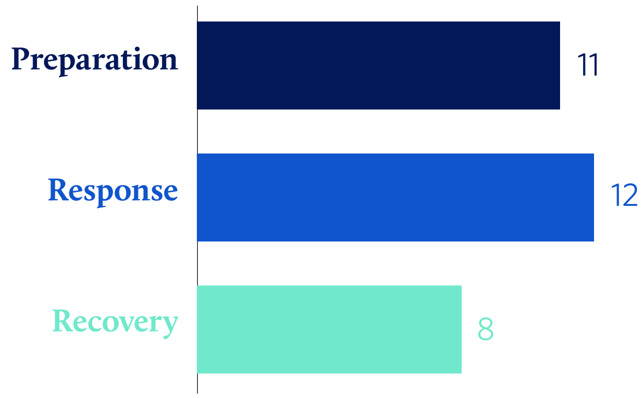
For the operations-based test, the ISR distributed the mock RFP to its community and invited scientists to submit research concepts that would utilize ISR-facilitated resources. A total of 782 community members, identified as scientists who could meaningfully contribute to addressing a wildfire crisis, were invited to submit research concepts within an 11-day window beginning March 21 2022.

SUBMISSIONS

The ISR prepared a submission and review platform to process RFP submissions. More details about the review platform can be found in Appendix 3. The ISR received a total of 18 actionable research concepts from nine countries: Australia, Brazil, Chile, Kenya, Peru, the Philippines, Trinidad & Tobago, Turkey, and the United States.

Concepts were evenly distributed over three defined phases of crisis—preparation, response, and recovery—indicating interest among submitters in addressing a wide range of needs. The represented scientific disciplines were very diverse, ranging from fire detection and modeling to hydrology, paleoecology, and sociology. The range of approaches and interests supports the idea that scientists with interdisciplinary perspectives

Crisis phases addressed by RFP submissions



want to contribute to crisis response. More information about some of the scientists and their proposals can be found in Appendix 4.

The scientists requested all of the offered resources for use in their concept proposals, including technologies such as computing platforms or remote sensing; human expertise including data analysis, local knowledge, and interpretation; and geospatial data.

REVIEW STAGE

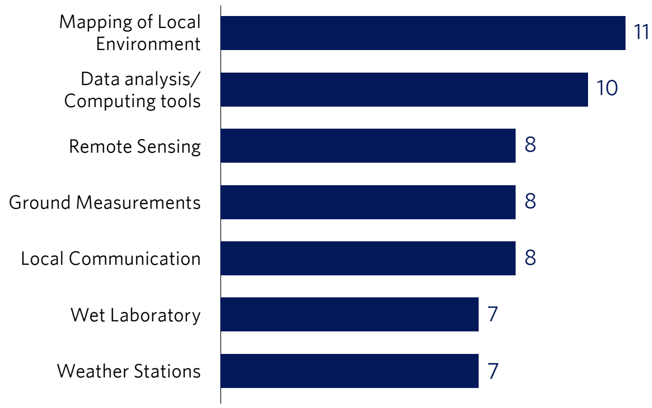
Submissions to the mock RFP were sent to a panel of experts for review. The panel included experts in wildfires, resource allocation during crisis, and general scientific proposal review. Each submission was assessed for quality, potential impact, feasibility, and resource utilization.

Experts first reviewed submissions electronically in the submission platform, and selected eight submissions for further discussion in a Proposal Review Meeting.

While reviewers were impressed with the degree of international representation, they also noted the relatively low number of submissions, considering the large number of scientists invited. Reviewers speculated on a number of possible factors for the relatively small yield. For example, both reviewers and participants called attention to the significant amount of time and effort required to develop a proposal. In the absence of a real crisis or an incentive for submission (such as resources, prize money, or recognition), researchers may simply be too busy to develop a quality proposal in a short time period. Reviewers suggested this may also explain the relatively high number of early career researchers who submitted proposals. Younger scientists have a greater need for new professional connections that could result from participation in readiness activities.

Reviewers said they wished the research concepts had contained more detail about how resources would be utilized. This shortcoming would inherently be addressed in proposals during a real crisis, when longer submissions would be required. The lack of detail made it difficult to answer some fundamental questions, including whether the resources offered as part of the readiness exercise could be generalized to address different kinds of crises.

Resources requested by RFP submissions



Reviewers proposed a number of steps the ISR could take to identify general resources that could be deployed across crisis types, including facilitating discussion-based testing for a number of different crises. An inverted approach to resources was also proposed: instead of beginning with a set of crises and pre-positioning resources to address them, the ISR could identify several resources that could logically be generalized and then prepare for crises that could utilize those resources.

The ISR also sought feedback from the submitters in a post-submission survey and in-depth interviews. Information from these interviews will help improve the submission process and platform, and will provide important details for how resources would be utilized in an actual crisis.

Several submitters said they felt more prepared for a crisis because the Wildfire Readiness Exercise prompted them to think, in advance, about how they would respond. This supports one of the central goals of the exercise: to give scientists time to prepare. The ISR is hopeful that future readiness exercises will see greater engagement, and based on the experiences of scientists who participated in this exercise, that future exercises will have a positive impact on participating scientists.

ABOVE: Meenakshi Dewan maintains solar panels she helped install in Tinginaput, India, as a "barefoot" solar engineer.
Credit: Photo © Abbie Trayler-Smith / Panos Pictures / Department for International Development

04 Lessons Learned

By building the Science Community and completing the Wildfire Readiness Exercise, the ISR gained important insights into its own methods and strategies, and these will help to validate the model and shape the next steps in preparing the ISR for full deployment.

1 Scientists want to join interdisciplinary communities focused on crisis response.

- In just a few months, the ISR successfully recruited more than 1,000 scientists from over 90 countries with the simple goal of preparing scientists, as a community, for future crises.
- The rapid recruitment of such a diverse, collaboration-oriented community validates one of the central tenets underlying the ISR: many scientists are eager to work outside of their own research silos and contribute to solutions to real-world, international challenges.
- This collaborative spirit was further reflected in our survey of participating scientists. Of the scientists participating in wildfire research who we surveyed as part of our readiness exercise, 90 percent pursue cross-disciplinary work. Over 80 percent of the scientists who have never participated in wildfire research want to join collaborations to address wildfire crises.

2 It will take iterative, user-centered design approaches to develop scientific readiness exercises that engage active scientists in preparing for crises before they occur.

- While the ISR observed significant interest in the concept of crisis readiness—in the form of community sign-ups—and identified nearly 800 scientists in the Science Community that could meaningfully contribute to wildfire crisis response, we received only 18 actionable submissions to our first mock request for proposals.
- The ISR might further engage with scientists in preparedness by reducing barriers to participation. It may be that crafting a research concept and submitting it for review, as was requested in the Wildfire Readiness Exercise, is too burdensome for active researchers, without the motivation of an active crisis. Methods to increase participation could include expanding the submission time period, designing the RFP to make submission easier,

or offering incentives. More frequent and low-effort engagement activities may also help maintain interest within the community, making scientists more likely to participate in discrete exercises. These hypotheses and methods can be tested with further prototyping of different readiness exercises, designed with input from a more varied set of experts.

- The ISR's Wildfire Readiness Exercise demonstrated a strong potential for scientific preparedness, while more testing is needed to evolve new methods to meaningfully engage scientists in readiness activities.

3 Consensus exists among scientists regarding which resources are needed to address a particular crisis, but more work is required to understand how resources can be generalized across crisis areas.

- Scientific crisis readiness is contingent upon the availability of resources needed to perform crisis-related research. To prepare for a given crisis using the initial ISR model, the necessary resources must be ready to be deployed when a crisis occurs.

- In preparing and executing the Wildfire Readiness Exercise, the ISR found that scientists agreed which resources were needed to address wildfire crises. Consultation with North American scientists in academia and the U.S. Forest Service, coupled with survey data from members of the ISR Science Community, yielded eight types of resources that could be applied across wildfires. This means organizations can pre-position resources in advance of particular crises, and that needed resources can be identified ahead of time.

- However, how to pre-position resources for a response to a broad range of complex global crises, as divergent as wildfires, pandemics, and cyberattacks, remains an open question. The ISR convened and surveyed experts on resources, crisis response, and wildfires throughout the Wildfire Readiness Exercise, and found differing views about which resources could be applied to crises besides wildfires.

- Generalized resources, those that could be utilized in multiple crisis areas, are the most logical focus for organizations seeking to simultaneously prepare science for different types of crises. The ISR will continue to investigate which resources can be applied across crisis areas.

The ISR is committed to building on the achievements of its first year, and exploring additional crisis readiness scenarios. Our experience with the first readiness exercise has demonstrated that ongoing development and practice can help empower scientists to act when action is needed.

A1 Wildfire Crisis Scenarios

Each scenario was drafted to provide concise and sufficient information for scientists to respond, and each begins with a brief narrative description of the nature of the fire and the environmental conditions. The scenarios also specifically identify values at risk (*e.g.*, proximity to the humans, potential for spread), examples of science-based intelligence (*e.g.*, local mapping of fuels and water, models of smoke spread, evacuation routes), and expected recovery needs (*e.g.*, prevention of landslides, water contamination, relocation assistance).

Scenario A: Crown Fire in the Northwestern United States

In the Northwestern United States, a crown fire is moving rapidly through remote, mountainous terrain not easily accessed by fire responders. The fire is now approaching the border of Canada. The fire's fuels include high elevation lodgepole pine and mixed conifer forests. The weather has been hot with high temperatures, low humidity, and windy conditions. There are red flag warnings with embers blowing more than 5 miles from the active fire front. The fire is active during the day and at night and is difficult, if not impossible, to suppress, and expected to be of long duration (30-60 days).

AT RISK:

- Several thousand people living in multiple small, unincorporated towns in the area are currently threatened by the spreading fires.
- Towns are interspersed across the landscape and have critical water resources: watersheds, surface water sources used for irrigation and human consumption, and well water for domestic and commercial use.
- Evacuation routes not clearly defined.

EXAMPLES OF SCIENCE-BASED INTELLIGENCE NEEDED:

- Developing multiple evacuation routes given fire behavior predictions
- Mapping and fire behavior modeling outputs (predicting fire behavior for next 7 days)
- Locating potential fire suppression control lines
- Modeling where smoke plumes will impact both evacuation routes and fire responders
- Mapping of where water resources are, and which can be used for fire suppression

POST-FIRE RECOVERY NEEDS EXPECTED:

- Flooding/landslides
- Water contamination
- Economic and social impacts
- Understanding housing relocation/assistance for impacted residents

Scenario B: Forest Fire in Greece

There is a fast-moving surface fire spreading through the brushy forests of Greece that resembles the fires that ravaged the Greek countryside in 2021. The region has now been facing drought conditions for several months and the fire is spreading rapidly in the low humidity, high temperature, and high wind conditions. The available fuels are the light, flashy, brushes common along the Mediterranean coasts. The terrain in the region is not difficult to access, however, fire responders are having difficulty safely engaging the fire because of its rapid movement day and night. The flame front is quickly approaching a large built community, and there are few fuel breaks between the existing flame front and town.

AT RISK:

- Wildland urban interface is threatened: dozens of homes have burned, 20 people have been injured, and 2,000 residents have evacuated from several nearby towns.
- Several hundred residents living dispersed through the landscape are also threatened.
- Water resource degradation/contamination unknown
- No room for error in evacuation planning due to fast-moving fire
- Smoke impacting communities a considerable distance from the flaming front, including ones across national borders
- Co-occurring fires throughout the region (*i.e.*, Italy and Turkey) mean that usual partners are unavailable for support.

EXAMPLES OF SCIENCE-BASED INTELLIGENCE NEEDED:

- Developing multiple evacuation routes given fire behavior predictions
- Building appropriate data layers/databases (terrain, community locations, fire weather metrics, etc.) to be able to run fire behavior models (*e.g.*, predicting fire behavior for next 7 days).
- Locating potential fire suppression control lines
- Need to develop and use data layers to model where smoke plumes will impact both evacuation routes and fire responders
- Mapping of where water resources are, and which can be used for fire suppression

POST-FIRE RECOVERY NEEDS EXPECTED:

- Flooding/landslides
- Water contamination
- Economic and social impacts
- Regional recovery considering neighboring partners will also need aid
- Housing reconstruction

Scenario C: Peat Fires in Indonesia

Fire season has arrived in Indonesia and peatland fires have flared up in multiple provinces. The fires have reached a 1.75 million acre area of peatland that is home to two wildlife reserves, which host multiple endangered species. Thus far, the fires have burned 200 acres of the bioreserve. After a week without rain, due to dry conditions and the nature of peat, the fires (called peat fires or "zombie" fires) have spread underground and are smoldering. The fire has reached proportions where it is difficult to control by the ground team; rain is typically the only way to extinguish these types of fires once they have spread. The spatial extent of the fire is challenging to detect as it is predominately underground. Fire has made its way from underground to ignite flammable surface fuels.

AT RISK:

- Toxic smog has reached hazardous concentrations and plumes of smoke have stretched to neighboring countries.
- Concern that underground peat fire will transition to surface fire in a location near a community with no warning.
- Communities in the region are not directly threatened currently, but are vulnerable to surface fires should the peat fire spread above ground.

EXAMPLES OF SCIENCE-BASED INTELLIGENCE NEEDED:

- Surface fire behavior models, mapping tools, etc. may not provide robust intelligence for this crisis.
- Uncertain how these fires may impact water resources
- Smoke modeling is needed to understand where/how smoke will impact communities.

POST-FIRE RECOVERY NEEDS EXPECTED:

- Peatland restoration
- Economic and social impacts
- Health impacts of smoke

A2 Resources Available for Wildfire Readiness Exercise

For the purpose of the Wildfire Readiness Exercise, the ISR offered a range of resources.

- **LOCAL COMMUNICATION**: Access to scientifically-literate interpreters and/or partners with local knowledge of environment, government response mechanisms, and culture.
- **WEATHER STATIONS**: Temporary remote weather stations that can be installed in the region surrounding the wildfire.
- **DATA ANALYSIS AND COMPUTING TOOLS**: Devoted time & computing power on HPC platform or other analysis tools, such as an artificial intelligence (AI) platform.
- **DATA ANALYSTS**: Deployment of programmers fluent in open-access language (such as R) and high-level geographic information services to customize and develop models.
- **MAPPING OF LOCAL ENVIRONMENT**: Databases containing population density maps, maps of built environment density and construction materials extracted from tax records, and maps of natural fire fuels.
- **REMOTE SENSING**: Access to remote drone and/or satellite measurement tools for up-to-date data collection as the fire spreads and is suppressed.
- **GROUND MEASUREMENTS**: Deployment of field technicians to gather data from the immediate wildfire area.
- **WET LABORATORY**: Access to local wet lab for chemical analysis of samples (*e.g.*, soil, biomass).
- **OTHER**: Specify additional resources to which you would like access.

A3 Proposal Submission Process & Platform

Proposal submission process

For the ISR to respond when a crisis is declared, the ISR must have systems in place to rapidly notify the scientific community, accept submissions from scientists, and match resources to projects. In the Wildfire Readiness Exercise, the ISR built a process to similar to what might be used during a real crisis.

The ISR used the following discrete steps and platforms:

1 Scientists were sent the mock request for proposals by email;

2 The notification email linked to a custom landing page with high-level information about the exercise and the wildfire crisis scenarios;

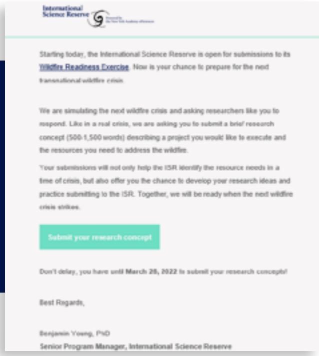
3 The landing page linked to a PDF with instructions for submitting a research concept, the complete scenarios, and the list of offered resources offered;

4 The instructions file linked to the submission platform, where scientists were instructed to sign in or create an account, and then to submit their research concept.

In an attempt to increase the number of quality proposals, the ISR designed each step in the journey to drive scientists to the next with a digestible amount of information to avoid overwhelming and discouraging potential submitters. The process was designed iteratively using usability testing to assess and refine the process.

The RFP asked scientists to submit a research concept describing a project addressing a specific wildfire crisis scenario for which they would like to gain access to resources. The research concept was to be 500-1,500 words and scientists were asked to specify the resources they required. Scientists also categorized their research concepts according to the crisis phase it would address: preparation, response, and/or recovery.

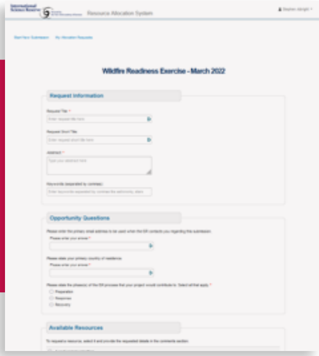
1 EMAIL NOTIFICATION



2 LANDING PAGE

3 PROPOSAL INSTRUCTIONS

4 SUBMISSION PLATFORM



SUBMISSION PLATFORM

To facilitate the submission, review, and resource matching on a single platform, the ISR used the National Science Foundation's Extreme Science and Engineering Discovery Environment (XSEDE). XSEDE is a virtual system that scientists from around the world use to interactively share computing resources, data, and expertise.[8] The ISR used a specific module of XSEDE, the XSEDE Resource Allocation System (XRAS).

XRAS was chosen as the submission platform because it is highly customizable, contains linked submission and reviewer sites, and is designed to match projects with resources.

To further facilitate accessibility, XRAS was linked with ORCID (Open Researcher and Contributor ID) for logging in to the platform. ORCID records are unique identifiers for researchers, and many in the ISR community likely already possessed ORCID records. Those who did not have an ORCID record were directed to an external link to set up an account.

[8] https://www.xsede.org/about/what-we-do

A4 Selected Profiles of Wildfire Readiness Exercise Submitters

Matthew Adeleye
The Australian National University
Australia

Matthew Adeleye is a paleoecologist who studies fossilized plant remains to understand long-term interactions—mainly Pleistocene and Holocene epoch—between ecosystems (vegetation and wetlands), fire, climate, and human impact. Although his current research in Nigeria and Australia focuses on terrestrial vegetation, Dr. Adeleye has a longstanding interest in peatlands. This led him to address ISR's Indonesian peat fire scenario for his readiness exercise proposal, which applied paleoecological insights and techniques to identify significant long-term impacts of the wildfire and fundamentally improve the region's recovery.

Vinicius Albani
Universidade Federal de Santa Catarina
Brazil

Vinicius Albani is an assistant professor of mathematics who has a passion for combining theory and practical application. His recent international collaborations have included publications that have contributed to modeling the evolution of the COVID-19 pandemic. In response to the ISR's Northwestern US crown fire scenario, Dr. Albani and his colleagues proposed combining their expertise in mathematical, statistical, and computational modeling with key wildfire data to form accurate long-term fire-spread forecasts that could assist in both preparation and response.

Fulya Aydin-Kandemir
Hydropolitics Association (HPA) & Akdeniz University
Turkey

Fulya Aydin-Kandemir is based in Turkey and regularly collaborates with scientists, internationally. She brings a scientific background in theoretical physics and life sciences to climate change research spanning geographic information systems, spatial analysis, remote sensing, climate change projections, and land use management. For her ISR readiness exercise proposal, Dr. Aydin-Kandemir collaborated with colleagues from Turkey and Greece by drawing on several of these areas to elaborate a plan for GIS- and remote sensing-based mapping of regional water resources to assist both prevention and suppression of the ISR's Greek wildfire scenario.

Daisy B. Badilla
Philippines

Daisy B. Badilla is a chemical and environmental engineer who has studied biofiltration as an air pollution control technology. She previously worked for the Philippine Nuclear Research Institute as Supervising Science Research Specialist and currently helps provide safe drinking water to indigenous communities in Palawan, Philippines. For her readiness exercise proposal, Dr. Badilla proposed using her background in air quality research to track the spread of toxic gases released by the Indonesian peat fire scenario and institute a tailored public awareness campaign to minimize health impacts.

Roberto Dias
Fundação Arthur Bernardes/Petrobras & Universidade Federal de Viçosa
Brazil

Roberto Dias is a biologist who directs research in molecular biology, virology and biotechnology. He currently focuses on using microbiological markers to aid the recovery of areas affected by climate change. Dr. Dias and his colleagues chose to address the ISR Northwestern US crown fire scenario for their ISR readiness exercise proposal. They considered how machine learning and predictive modeling could be used to understand the effect of wildfires on soil microbiota and support regional recovery.

Tracy Marshall
Department of Geography, The University of the West Indies, St. Augustine
Trinidad and Tobago

Tracy Marshall studies households and their behaviors to assess, understand and improve their levels of disaster preparedness. She used this expertise and her professional background in risk, crisis and disaster management—including at the national level in Barbados—for her ISR readiness exercise proposal. Ms. Marshall proposed a socio-demographic, place-based household wildfire risk assessment in response to the ISR's Northwestern US crown fire scenario that would inform targeted risk communication and community preparedness practices to save lives and make households more resilient.

Malik Padellan
Regeneron Pharmaceuticals
United States of America

Malik Padellan is an early-career bioengineer who currently works as a process scientist, focusing on optimizing manufacturing processes. For his readiness exercise proposal, Mr. Padellan combined the ISR wildfire scenario with another scientific interest of his to propose testing wildfire spread detection utilizing signaling by genetically-modified fungal networks that respond to heat.

Avid Roman-Gonzalez
Business of Engineering and Technology S.A.C. (BE Tech), Universidad Nacional Tecnologica de Lima Sur (UNTELS) & Universidad de Ciencias y Humanidades (UCH)
Peru

Avid Roman-Gonzalez is an electronic engineer specializing in areas including image processing, bioengineering and aerospace technology. His professional background includes work for companies such as the French Space Agency (CNES) and the German Aerospace Center (DLR), as well as teaching appointments at multiple universities. For his ISR readiness exercise proposal, Dr. Roman-Gonzalez built on his existing work in risk and disaster management and suggested using satellite images to inform localized wildfire response efforts.

Daniel San Martin
Universidad Técnica Federico Santa María
Chile

Daniel San Martin is a computer scientist who designs models to respond to and prevent Chilean wildfires. For his ISR readiness exercise proposal, Mr. San Martin chose to apply a Graphic Processing Unit (GPU) framework to ISR's Greek wildfire scenario, using mathematical models and high-performance computing to implement real-time analysis and forecasting of fire dynamics that would allow faster and better decision-making in the response efforts, as well as prepare for future outbreaks.

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We offer our appreciation to the scientists from more than ninety countries who joined the ISR global community.

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