



Marshalling global research infrastructure to address emergencies: Incorporating resilience and agility in research infrastructure planning, financing, and operations Plenary 2

Moderator:

Dr. Joy Johnson, President and Vice-Chancellor, Simon Fraser University

Panelists:

Xavier Barcons, Director General, European Southern Observatory

Werner Kutsch, Director General, Integrated Carbon Observation System

Beryl Morris, Director, Terrestrial Ecosystem Research Network

Anna Panagopoulou, Director, European Research Area and Innovation

Moderator: Good morning, everyone. Good evening and good afternoon. My name is Joy Johnson and I'm the President and Vice-Chancellor of Simon Fraser University in Vancouver, Canada.

Welcome to our panel: Marshalling global research infrastructure to address emergencies incorporating resilience and agility in research infrastructure planning, financing, and operations.

We have a fantastic panel with us today and I'm going to just briefly introduce all of them to you.

We have Dr. Barcons. Dr. Barcons has been the European Southern Observatory Director General since 2017.

We have Dr. Kutsch. Dr. Kutsch is the Director General of the Integrated Carbon Observation System and he's been in that role since March of 2014.

We have Dr. Morris with us today. Dr. Morris is the Director General of the Terrestrial Ecosystem Research Network.

And finally last but not least, we have Ms. Panagopoulou, who is the European Research Area and Innovation Director with the Director General for Research and Innovation with the European Union.

Welcome to all of you. It's great to have all of you with us today. More detailed bios for our panelists are available.



So let's get started and I'm going to just ask you to begin with, those of you who are with major infrastructure projects just to briefly tell us a little bit about your infrastructure and maybe a challenge or two that you've experienced in the last year and a bit with the pandemic. And I'm going to start with you, Dr. Barcons.

Dr. Xavier Barcons: Thank you very much, Joy.

We, at the European Southern Observatory (ESO), are an intergovernmental organization and we build and operate large astronomical telescopes in the ground for more than 50 years now. So we are actually operating for the benefit of the community some of the most powerful instruments like the very large telescope, ALMA, together with our international partners and those who are building new big facilities like the extremely large telescope.

This year has been especially challenging as you can all imagine. I had to make progress in our projects without being able to travel, without being able to have everyone on site with industry being also in trouble with some limitations and still operate our facilities delivering data to the scientists, which we could do at least during a good part of the year. So yes, overall very challenging but also with lots of lessons learned, I would say.

Moderator: Thank you. Dr. Kutsch.

Dr. Werner Kutsch: ICOS is a distributed research infrastructure. You can see the network behind me and we have invested a lot in concrete and steel but not in once place, it's distributed over 13 European countries and we are observing greenhouse gases, we are measuring, for example, the fluxes between natural ecosystems and the atmosphere and this brings us of course, very closely to the societal challenge of climate change. We are not only working in ecosystems, we are also measuring the fluxes between the oceans and the atmosphere and we are doing direct measurements of the concentration in the atmosphere. But it's not only about concrete and steel, it is also about a very nice community of technicians and of scientists who maintain the station but also use the data and provide knowledge to the society, for example, to the IPCC or to the U.N. Climate Convention. And lucky me, we have a lot of automated systems so we came quite well through the crisis and to the shutdown and interestingly, we also could measure some of the impacts of the shutdown. Mainly on the fluxes it has



not so much influenced the concentration in the atmosphere of greenhouse gases.

Moderator: Thank you very much.

Dr. Morris, I see an image that's similar to one that's behind you. Why don't you tell us a little bit about your infrastructure?

Dr. Beryl Morris: Thanks Joy. Yes, TERN is the Australian continent's ecosystem research infrastructure. So we do some carbon monitoring, but we also do a whole range of other things. We've been in existence since 2009, funded by the Australian Government to do the whole of the Australian continent and from the Southern Hemisphere into all the global collections of data about what's happening in the environment. So we have remote sensing and we have about 800 sites across the country that we do time series surveys at, and we have 15 really highly instrumented sites from which we can work out what's actually happening, what processes are happening in the ecosystem. And COVID happened very quickly after Australia had some devastating widespread bush fires and TERN was hoping to be able to do a lot of work in the field monitoring recovery and effects of bush fire on our ecosystems and biodiversity. But with lockdown, as has been mentioned by others, it was not possible to get into the field and it was also exacerbated by the effect of the bush fires, some of the sites were just too dangerous to go to with trees still falling and things like that. So we managed to run everything that was instrumented continuously as we normally do, but things that relied upon our field crews being out and about maintaining equipment and gathering data were severely affected.

Moderator: Thank you very much.

We've heard about three really interesting large scientific infrastructures and I'm going to ask you a first question, Ms. Panagopoulou. I'm wondering if you can maybe talk a little bit as a funder. What do you see as the key ingredients for these partnered arrangements across countries?

Anna Panagopoulou: Thank you very much for the invitation, very happy to be with you today.

In the European Commission, we have a lot of experience on not only funding research infrastructures but pooling together collaboration between different research infrastructures across Europe and beyond. So the main ingredient for pooling these infrastructures together, it's first of all to establish an international collaboration about specific things and areas.



Second, to align the priorities among who should be those infrastructures to be considered as they once were public investments coming from the European level but also a national level could contribute to create incentives for establishing international or [00:07:55 *both of these were different distributed*] infrastructures could collaborate between them and as well as create incentives for utilizing the data, the results of research infrastructures but also provide access for scientists to those research infrastructures so that the outcome of this collaboration could be beneficial not only for the infrastructure itself or the network infrastructures, but also for the European society and Europe in general and beyond. So in this context, I would like also to highlight that in the context of the pandemic, we put in place a new platform, the European COVID-19 data platform, in a very short time, on the basis of existing infrastructure in order to collect data that are related to the pandemic. And I'm happy to announce that we have by now, in less than a year, 140,000 users and 3.6 million web requests, over 170 countries, which demonstrates that collaboration between different infrastructures at the international level and who provide data that are very important for the public needs.

So that's my short introduction.

Moderator: Thank you very much.

We've heard a little bit about some of the key ingredients, I'm wondering if there are other ingredients on the ground in terms of this kind of coordination, what is the magic behind this partnership? Dr. Barcons, do you have anything else to add in terms of what you see as key ingredients?

Dr. Xavier Barcons: Well yes, but I think I agree with what has been said so far. I mean, we were born international, right? We have 16 member states today and actually, we are part of a bigger project, which is called ALMA and there we're partnering with the United States, with Canada, with Japan, Taiwan, South Korea. So it all gets really global when you try to put together an infrastructure that it's powerful enough to meet the requirements from science, from society in any respect. Then the trick, of course, is to get the right governance model for these things and this is not always particularly easy. Our experience being an intergovernmental organization on our own that has been incredibly helpful, we can plan, and we can develop long-term projects. We know to a high level of precision, the funding that we will have for them in 10 years from now and those things are really the basic



ingredients. Of course, the challenge is to get everyone behind the same project and this is super important, I would say.

Moderator: Dr. Morris, I see you nodding along there in terms of both governance but also alignment.

Dr. Beryl Morris: Yes, exactly. Both Dr. Werner Kutsch from ICOS, and myself at TERN, have had the pleasure over the last few years of putting together a global ecosystem research infrastructure, which combines the efforts of Australia, South Africa, China, the U.S. and Europe in forming a global group. And the key ingredient there was first of all, working out how we would structure the governance to sort out all the issues of how we would communicate, resolve any conflicts and exactly what we would do together in that environment of what we call GERI or "Gary," depending on who's pronouncing it, Global Ecosystem Research Infrastructure. And so I think it's been a really good structure to make sure that there is harmony across all of the continental scale observatories of the world to being monitoring's and common parameters that it may add some great benefits to groups that have to make global type decisions about how the environment is tracking, particularly in times of crisis.

Moderator: And Dr. Kutsch, I see the diagram up behind you of all the partners involved. I'm wondering. Are you seeing more openness to these types of collaborations? I'm curious about that.

Dr. Werner Kutsch: Definitely there will be some openness. Let me perhaps first say that seeing this map of these different infrastructures and all the stations, of course it's giving some challenges. The motivation for that is, of course that climate change, greenhouse gases and any other environmental problems usually are not stopping at national borders or between continents. They are global and that's why we need also in our science, a global answer but this brings also some challenges. Dr. Morris already mentioned the governance part. It's also very important that we have, for example, standardization between the observations. That's something that we are longing for that we are not comparing apples and oranges between the different networks. And you can see there are huge gaps between the networks. Europe is very concentrated with the stations, and between the European and the South African partner, there is a big gap over the African continent. You can also see behind me that there is not much in South America. Central Asia is missing and so on and so on. And definitely we are open to connect to these regions, to research organizations, to research infrastructures in



these regions, but we are also open to support these regions to build up infrastructure in case this is not there at the moment.

Moderator: That's interesting. Not every country, obviously, has access to funds to build infrastructure to be part of these kinds of networks. And I'm just wondering, and maybe I'll go to you Ms. Panagopoulou. In your view, what are some of the ways that we might be able to involve countries in this type of infrastructure when they do not have the funds? Is there a role for these countries to play?

Anna Panagopoulou: First of all, I would like to say that being possible to accommodate the needs of developed nations and integrate them in the network of research infrastructures is clearly one of the priorities that we look at in the European Research and Innovation Policy, and in particular, on the context of the next framework program, [00:15:14 *Euro Asia*] and Europe.

As it was said, the global challenges are global challenges and there are no borders between Europe and the developed countries, so it's extremely important that we involve countries such as Africa. And for this region, the European Commission plans to fund a [00:15:34 *Euro Asian*] initiative with African greenhouse conservation, for example. And we have seen concrete priorities in the context of the new calls on the [00:15:44 *Euro Asian*] Europe program for research infrastructures. Distributed research infrastructures in this sense are opening up new opportunities for corporations that didn't exist before. But also, what was said by Mr. Kutsch, it's a matter of trainings providing support and educating those scientists from the developed countries in order to be able once they participate with the network to run activities in their research infrastructures. So this is something that also we see that we do need to finance with the support of scientists and research and infrastructures that the well developed and established in Europe and beyond in the context of international cooperation.

Moderator: Thank you for that.

Dr. Barcons, I'm wondering if you see ways that you can involve scientists internationally, particularly from countries that might not have the funds for this type of infrastructure?

Dr. Xavier Barcons: I think there are two aspects and two answers to this question. One is on the usage of the data that the research infrastructures obtain with a lot of effort. On this topic, there's now a wave of open data access all around the



world which we in astronomy and in space sciences, we had already put together 40 years ago by making all the data available to everyone openly in our archives, together with the tools to deal with them. This is extremely important. This is the tool that you need to train the new generations of scientists, the young people in all the countries not just in the developed ones. Not even the owners of the infrastructures because the data ends up being accessible to everyone. So that's one aspect that we need to cultivate and keep working on it.

A different one is how to help to develop the infrastructures themselves. I'm sitting with a nice picture in my background. This is the very large telescope in Cerro Paranal in the Atacama Desert in Chile. This is a facility. This is a very powerful astronomical observatory that our organization built 25 years ago. It's the most powerful telescope in the world, and we are seeking opportunities to partner locally with the Chilean community which has experienced a tremendous burst in their knowledge in astronomical technologies and in data mining techniques and so on. And I think this is a very good starting point for everyone.

We also have an instrument development program where we develop through control share of R&D institutes mostly in our member states but also elsewhere and that is also a very good forum if you want to really get engaged on state-of-the-art technologies that are helpful in principle for astronomy but also for other purposes. And we're also supporting these types of initiatives, which I think is the best way to engage the community internationally.

Moderator: Thank you.

And Dr. Kutsch, would you agree? Do you see similar kinds of arrangements happening from your standpoint?

Dr. Werner Kutsch: Yes, perhaps with a small difference. We are also trying to get support or to encourage these developing countries to get infrastructure and observations on the ground in their countries. And that's, I think, very important if you think, for example, on the global negotiations on climate change, they need to have their own observations, their own truth, and I think in particular, when it comes to adaptation to climate change, they need a lot of information about their ecosystems and about their agriculture, for example. So that's why we are really trying to support them in getting their perhaps, adapted observational systems, and we have already



finished a project together with African countries where we really tried to listen more than to tell them what they should do. And this listening was in a way also showing us that perhaps high tech approach that we have in the European countries is not always the best approach in developing countries but it could be an interesting combination to get this information also on the ground there.

Moderator: So adapting your infrastructure to the local context. I see you nodding there, Dr. Morris.

Dr. Beryl Morris: Yes, we have some good programs that we've been involved in not as extensive as we would hope but there's one in particular, which is an ecological education program that was commenced some philanthropists in Korea to make it possible for people in underdeveloped countries, first of all through Southeast Asia but they're hoping to expand it to go visit and carry out work at research infrastructures sites in more developed countries. And so in TERN, we had three of our sites that have been appraised and are going into the catalogue of sites that students, both undergraduate and graduate students from Southeast Asia, can come learn how to do things, carry out some of their experiments using the infrastructure that wouldn't be available to them locally at this stage. We also have made our protocols available in quite a few different countries. It means that anyone who is starting to develop some of their infrastructure doesn't have to start from zero. They can take a guide to how to do everything. And relatively recently, we sent a party of our people from TERN into Borneo where they were setting up some flux towers, and we helped with the construction and provided all of the protocols that they would then be able to go on and continue operating it. So everything that we have, as Dr. Barcons said, is openly accessible around the world and all of the data, just looking at our publications, there are some fabulous publications showing international collaborations from as many countries as you can count, because they're out to get data that allows them to look at things using what our infrastructure has collected and then reflect upon it at their local level, perhaps without such expensive equipment but still make it useful.

Moderator: You've touched on a few points there. One I want to pick up on and that's the use of this type of infrastructure for outreach and training, outreach to the public in particular. And I'm wondering, Dr. Kutsch. Are you involved in those kinds of initiatives as well using science, public outreach, and education?



Dr. Werner Kutsch: Well we have a few projects, perhaps I can mention a project that's under evaluation so hopefully this will be coming, because I think this is quite a good example.

We have recently submitted a proposal on urban observation, so we are measuring greenhouse gas emissions but also the vegetation inside urban areas and for this, you need a very dense sensor network. And in the proposal writing phase, we had the idea to put sensors on school buildings so that they are part of a scientific network but they have their own sensor at the schools, and I think this is an excellent way to get at least young citizens, students, involved into these kind of measurements that could analyze the measurements in their science education but also, perhaps one could put CO₂ sensors also for some time into the classroom and see a bit more about air quality in the classroom and so on and so on. I think getting the novel infrastructure that we are using as scientists towards citizens, or in this case young citizens, I think that's a brilliant way to get the message into the society. And of course, we are also informing through various channels and the general public on actual topics related to climate change and to greenhouse gases.

Moderator: Thank you for that.

And Dr. Barcons, do you find as well that increasingly it's important to be able to share information about this infrastructure with the public so they can understand the importance of these investments? Is that something that you're concerned with as well?

Dr. Xavier Barcons: In our case, this is even part of our mission to foster communication in astronomy and therefore, we have quite comprehensive programs of training people, studentships, fellowships in science, in engineering internships, but we also develop quite a lot of work in outreach. We have school visits to our observatories. We do have a visitor centre here in the headquarters in Garching. We have lots of online material and activities. We're doing guided tours through the internet now through our observatories. This is extremely important to maintain the engagement with society.

I have to say that it may be by coincidence, but the panellists, we are all happy runners of infrastructures that are very inspiring to society for a variety of reasons. And I have to say, I'm very pleased with this. It's very easy to communicate our sciences and we do it with a lot of pleasure.



But there's also another aspect here that I want to mention, which is that for us it's also operational needs. I mean, we need to train the new generations in skills that we can use. Not only us, but infrastructures like ours we'll need in the future. And this is also an investment from our side. It's of course, communication but also investing in our own future.

Moderator:

Well thank you for that.

I'm conscious of the time that we have that it's running down and we do want to get to questions today.

I really want to thank the panellists ever so much. You really have demonstrated the ways in which infrastructure partnerships need to be built. You've talked about the way in which you're responding to the emerging crisis of climate change. You've talked about science, the funding of projects and aspirations for the future. So this has been a great panel. I want to thank you for your comments today and we'll move on to questions.

Moderator:

Well I so enjoyed that conversation, and I look forward to inviting the panelists to join me for some questions. I look forward to submitting your questions. And while you're thinking about your questions, it's my pleasure to invite Dr. Petr Bartůněk from the Institute of Molecular Genetics of the Czech Academy of Sciences to make a short presentation that provides us with some information about a pre-ICRI workshop entitled Research infrastructures mobilization in response to COVID-19 lessons learned.

Dr. Petr Bartůněk:

Thank you, Dr. Johnson. Thank you for the introduction.

I'll just share today with you some keynote messages we learned during our workshop, which is OECD Global Science Forum (GSF) co-organized with Science Europe and was the virtual workshop held on May 11 and it was set up as a satellite of this conference. And we had around 150 participants, including geo-satellites. And actually, this workshop was a great opportunity to discuss some of the critical questions that emerged in the COVID-19 pandemic for different research infrastructure stakeholders, as well as draw some lessons and messages for future and how to tackle future emergencies, and more broadly, how to improve the efficiency of research infrastructures addressing both scientific and social challenges.

The workshop actually was set up in three sessions, including a case study presentation from research infrastructures from different research domains and was also moderated by different representatives of research agencies, funders, governments and also scientists.

I will start with the first session, which was called Adapting research infrastructure processes in emergency situations and we had case study presentations from Lifewatch-ERIC, EU-Openscreen ERIC, and Japan RIKEN Center for Computational Science. And to start with the first one, I will just have some bullet points today.

First, cooperative research infrastructure networks established priority crisis and greatly help in facilitate cooperative work and data sharing during the crisis. And also, we were able to relocate the resources and reorganize the operation procedures during the crisis very fast. We were actually partially working on in this in the virtual world, which requires specific training resources and so on, as you've all experienced. We had actually noted as well that there are some processes, including training, education and engagement of users, for instance, still might require physical interaction. So it's not so easy to replace it in a virtual world. One of the very critical aspects is sharing data and research data, especially and rapidly in such critical and emergency situations, but we have to find the proper balance and also validate all the results before they are disseminated externally because they might be misinterpreted or misused. I think we have some bad examples already in the world and in the media, so I think this is a very important aspect of that.

The other point is social, the impact of research carried out at research infrastructures, and very often those results are actually used to issue policy guidelines for the general public so I think it's also a very important part of it. And considering this sensitivity of this issue, I think there is a need of actually finding the mechanisms or communication mechanisms with media on how to inform public about results in a transparent way. And we hope that this will also help to increase public confidence in policy recommendations and in science in general. These are few points from the first session.

The second session was called Preparedness and response of life science and health research infrastructures, and we had representatives from BBMRI-ERIC; Canadian and vaccine and infectious disease organization, Vido; and Pirbright Institute for animal health and virology from UK.

Research infrastructures conduct stress tests in between crises and to actually assess their capacity to respond to emergencies and they should also include some assessment of commination challenges. And I think that there was a discussion, and I think most of the panelists agreed that the whole system should be more proactive to somehow facilitate response in future emergencies and this includes doing more networking, training of a special dedicated workforce that can be mobilized quickly so they are already established integrated structures to help that. And since we have some representatives from the vaccine world, I think a very important aspect and idea, I think I like it very much, was proactive development of vaccines. So we initiate even developmental phases by public research institutions maybe even with cooperation with industry on emerging diseases and this could dramatically reduce response times and resources needed for making new vaccines. And I think we had a very good example of that in the case of mRNA vaccines in [00:06:11] and this is a very good example which most of you actually realize in using Moderna or Pfizer, BioNTech vaccines. This is a good example of that.

And the last session was on policy lessons learned from COVID-19 pandemic and potential role of research. And this was actually a more open discussion. We had panel speakers from Science Europe, from Canadian Research Data Centre Network, French Agency for Emerging Infectious Diseases, Italian National Institute for Nuclear Physics and we have one organization from Ministry of Education of Czech Republic. The points were discussed that the crisis underlined the role of research infrastructures as catalysts and overall response of the science system and that research infrastructures are actually national assets or treasures for crisis management and there could be agreements between the research infrastructures and governments to formalize this role. And of course, this will require some appropriate support so that the research infrastructures remain in some kind of state of readiness for crisis response in future. Of course, this has to be done with a more transparent vision and of course, there should be priorities. And what is extremely important here to mention, there should be funding to ensure sustainability of research infrastructures, including some kind of capacity for emergency response. I think we have a broad spectrum or not only life science or infrastructure so I think we realize that there's a large diversity research infrastructure landscape we have to prepare because nobody could predict and actually know what would be the next future crisis. So I think this is more general that we should not say that the life science health infrastructures are the most important. I think



there can be other societal challenges which we can't even envision nowadays.

So those are the keys lessons I just shared today with you and they'll be contributing in future in the OECD Global Science Forum task force and part of it and mobilizing science in times of crisis. And if you are interested, I think there are a couple of really great presentations from global leaders and if you're interested, I invite you look at the workshop presentations. There are some video recordings and a summary paper also on the GSF website.

Thank you very much for your attention and thank you, Dr. Johnson, for allowing me to share with you these take-home messages.

Thank you.

Moderator: Well thank you very much, Petr. Very relevant to this panel discussion, the points that you've raised so I really appreciate you taking time with us today.

It's now my pleasure to welcome back our panelists and we have an opportunity to engage in some more discussion. I will invite members of the audience to submit their questions and we will get to those. I've got my first question up here and I'll read it out and we'll dive right in.

The COVID crisis led to the insight that we have to act globally and to better coordinate activities. However, the recovery funds often aim at strengthening national independence. Do the panelists see this as a risk for the GRIs that governments might want to investment in their own countries rather than international collaborations, that tension?

I'll start with you, Ms. Panagopoulou on this issue of nationalism versus globalism.

Anna Panagopoulou: Thank you very much for the question and it's very pertinent and actually, it comes at the right moment because we are currently receiving and evaluating all the recovery plans prepared by the European member states in order to help them to recover from the situation.

Indeed, the recovery funds are aiming at the national level but the European added value of how the member states they will spend to those funds is clearly highlighted in the context of the guidelines that the European Commission gave to them.



In addition, I would like to highlight that the positive thing that we've seen with the recovery plans that we receive now from the member states, that there are a lot of expenditures on research infrastructure in innovation activities. And the member states they want really, through research and innovation to support their recovery. And research and innovation, as you all know, is activities that at one side they are national but at the same time, they can only be effective and efficient if there is exposure at an international level. And behind research and innovation activities, there are a lot of partnerships between members states where also the resiliency recovery funds can contribute and what we have seen from the member states that while they are looking at the recovery at the national level, they [00:11:45] those are the possibilities of international collaboration at the same time. So we are very happy to see the outcome of this and I do believe that there is always a possibility to have a win-win situation between national interest and international collaboration in the context of research and innovation.

Moderator: Thank you very much.

Coming from a non-European perspective, Dr. Morris, do you see the same kind of dynamic playing out?

Dr. Beryl Morris: Yes. I think, obviously, science is funded at a national level. I think that the global ecosystem research infrastructure, of which our Australian TERN is part, is a very modular thing. Its six continental observatories collecting data and making it openly available, which means that scientists anywhere in the world can access that data and it means that they can look at things at a country level but they can scale globally with the data that's available to them. So the infrastructure support is still a global approach, while the science may be happening regionally so that it's contextualized to the needs of the funding area.

Moderator: Thank you very much.

We've heard quite a bit about data and the challenge of making it open. But earlier, we also heard from Dr. Petr Bartůněk about some of the challenges related to misinterpretation of data as well. I'm wondering, Dr. Bacons, if you experience those types of challenges about trying to determine across the infrastructure how data will be interpreted and shared.



Dr. Xavier Barcons: Thank you for the question.

Well yes, a little bit. We need to make sure that the quality standards of the data that are in the archives is understood and shared by everyone. So when you access from data from, in our case, an astronomical observatory, be that on the ground or in space, you need to be sure that those data are reliable and they are up to some minimal quality standards. So we have a series of descriptors and the like, which of course, the professional know how to handle them. And I think this is exportable to all types of data science, if it can be agreed on this equality level so everyone understands and knows the quality of the data that they are using.

Moderator: Thank you.

It's interesting, just kind of picking up on being open and some of the challenges. There's a question here, and this is really coming from the context of vaccine development coming from Janice Bailey in Canada. The new vaccines, she's stated, are proof of what international and public-private research can achieve, however, there's increasing and rapid governmental concerns regarding national security and research activities. And again, this is about this tension, I think. How can our international communities work with various governments and international organizations, including the OEDC to prevent new barriers to block research partnerships? I'm wondering if any of you are experiencing those types of barriers in terms of blocking research partnerships. Dr. Kutsch, is that something that you experience at all in your work?

Dr. Werner Kutsch: Well yes, I think we have sometimes barriers when it comes to openness of environmental data. Of course, there is sometimes a state of the environment in the country that the country doesn't want to show it openly and that makes it sometimes difficult. But in general, I would say we have a great spirit of sharing environmental data and perhaps coming back to the question of the recovery funds. I think that we really need a bit of these recovery funds exactly into this topic, into the research and into supporting the open data. I don't mind whether this money is invested nationally or internationally. I think it's not the question. The question is where they money is invested and unfortunately, we see that many of the countries are investing into old industries, in industries that are supporting the fossil fuel emissions instead of having more of a green deal recovery like the European Union is trying to have. But if you properly analyze it, I think a lot of this recovery will also recover the emissions, and having research on this



and having observations on this would be a very important scientific task that we have.

Moderator: Thank you very much.

I'm going to switch gears here a little bit. There's a question really about how the collaboration works and the question is, if you could please talk a little bit about the interdisciplinary aspects of your networks, what disciplines are involved. What are some examples of synergies that you've seen amongst the disciplines and the conduct of research?

Maybe I'll turn to you, Dr. Morris.

Dr. Beryl Morris: I think the environmental area that I work in is a perfect example. In ecosystem research, ecosystems involve a complete assessment of the chemical, the physical, the geological, the botanical, the zoological, atmospheric, there are just so many scientific disciplines that are required in order to understand the environment and it's quite challenging to bring such interdisciplinary approach to environmental research. Each discipline has its own language, it has its own culture and yet we want to layer, say, information about chemical fluxes over what's happening to explain maybe what's happening to the fauna and flora. So we have to find common ground, we have to find common standards of the way in which we measure changes in all those different disciplines so that we can integrate the data and take a multi-disciplinary and transdisciplinary approach to providing answers to very complex questions. And I think in the area of modeling in particular, where you're trying to bring models of climate and landscapes and water and forestry and species distributions and integrate them to give you one big picture about how you might predict changes in the environment. So we find that we need a lot of collaborative workshops to bring people together so that they can understand each other's disciplines so that they can work out how they can find the interfaces between those disciplines. And it's really exciting, it spawns entire new approaches to research at the interfaces of all the disciplines and it's very rewarding to see some of the answers that come from it.

Moderator: Thank you.

Dr. Barcons, in your area do you also see this kind of transdisciplinary work taking place and how is that working?



Dr. Xavier Barcons: Yes. I think we should consider this as an added value of research infrastructures. It even goes beyond what could be considered the traditional scientific disciplines like the maths, chemistry, physics, the biology, geology. In our organization, about two-thirds of the employees are engineers and we have engineers of all the disciplines. We have software engineers, mechanical engineers, electronics detector engineers, optical, etc. Bringing all these people together behind the same goal this is enormously enriching and we need them. We need to cross fertilize around our goals, around the goals of the research infrastructures and this is incredibly valuable at the end of the day.

Moderator: Thank you very much.

I've got another question here and it's about the importance of training the next generation to maintain and expand infrastructure. We did touch on this in the panel and the question really is: Are there any good examples of international training programs and whether you think this might be a useful approach?

Maybe I'll begin with you, Ms. Panagopoulou. Do you see examples of integration of international training programs in some of the work that you're doing?

Anna Panagopoulou: Certainly, yes and this is something that we have done in the past in the context of our framework program Horizon 2020, where we gave the possibility, in particular, with the concrete international cooperation activities and projects to reinforce the training with researchers coming from less developed countries using the research infrastructures, providing them access in the research infrastructures in order to be able to be up to date with the state-of-the-art but also to transfer this experience that they got back to their country. So we have a lot of examples. For example, I can give you an example of EU funds to JIVE ERIC, to train future scientists and engineers in Africa via collaboration with the seven African countries that will host telescopes in the VLBI Network and phased to stations for SKA. So we did do that in the past and we will continue to do it in the future. And I said, collaboration with Africa is extremely important but beyond that, also for European scientists and researchers, for us it's extremely important that through our framework program, we provide the funding and the possibility for accessibility trainings and up-skilling of the researchers in the research infrastructure. So we see the research infrastructures they do play a very important role and we will provide financing in this context.



Moderator: Thank you for that.

I'm going to turn to another question. It's really interesting and we again, touched on this a little bit but I'm going to pick it up again. The question is how do we bring society closer to the information and knowledge that these superstructures are providing? How do we make these research infrastructures reduce the time between research and concrete responses to solutions to specific problems, such as global changes, world food, sustainable development? How do we really demonstrate this type of responsiveness?

Dr. Kutch, do you have any ideas about that?

Dr. Werner Kutsch: Well first, I have a bit of a frustration because the research on climate change is going for 30 years and the response time is really slow. Perhaps this might accelerate now that I would say the situation is that many countries have clearly seen that we need climate neutrality in 20 years, globally. And I think that makes, hopefully, a difference. We are working on this for some time. We are, for example, doing some kind of science initiatives out of the ICOS state. We had an initiative about the European droughts two years ago, and now three years ago, and then we can clearly see what our data is and what the value of our data is to interpret the situation and also be more prepared for future impact of climate change and ecosystems. And that's a difficult but I think, very important task. We have 80 scientific organizations contributing to ICOS so we have a huge network of universities and research institutions and they are running ICOS stations but they are very keen also to use the data. And out of this, let's say ICOS community and also out of a global community that is using our data, we have some fast response but I personally believe it's still not fast enough and this needs a closer connection, I think. I would call it scientific services that we should develop and perhaps a bit hand suited to specific problems and this might also feed back to the structure of the research infrastructure. So I think that's a little bit of a gap, a bit of what we still have to develop and this is really services towards the more, let's say, societal and political sphere. We have a few examples, but being an infrastructure that just became operations in the last years and perhaps we focused a little bit, or it was right to focus on becoming operational, but now the next focus should really be on the scientific services and speeding up the knowledge transfer into the society.

Moderator: Well thank you very much.



I am seeing the clock tick down here and I think that's a really interesting question to end on. I think that there is a real challenge and what this panel has been about in part, is really about how we can marshal our infrastructure to respond to issues and how we can incorporate resilience into our planning, our finances and operations. And across our conversation, there are a number of lessons to draw on, on the importance of global cooperation, open science, developing good governance for these infrastructures so that they can be sustainable.

I want to thank all of the panelists. I've enjoyed engaging with you ever so much. Thank you for your time today. And I understand there's going to be a short break now and we will invite you back to the conference platform for the live parallel session and summary reports after the short break.