People, places, and the planet

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Dr Alexandre Caldas, a Director at the United Nations (UN) as Chief of Country Outreach, Technology and Innovation in the Science Division at the United Nations Environment Programme (UNEP) and Chair of the United Nations Geospatial Network across 40 agencies of the UN, talks to *Nature Computational Science* **about the importance of data availability, the Sustainable Development Goals, and evolving policy.**

What do you see as the most pressing environmental issue that threatens a more sustainable future?

I think it is the triple climate crisis, which includes climate change, biodiversity loss, and pollution. One has to realize these days that this crisis is impacting humanity at large, not only our sustainable development but also many humanitarian areas, such as peace, security, and human rights needs. All of these dimensions are complementary for sustainable development, but they are very much intertwined with the triple climate crisis, and a Nexus approach — which incorporates the analysis of the interconnection of different sectors — is needed. Pollution needs to be understood in the wide scope of the different areas of the environment. This is important because it is also a simplification that we designate the environmental areas that are impacted by pollution in terms of air, water, land, biota/biodiversity and oceans. By this metric, one can understand why pollution becomes a big issue. For example, many are familiar with the problems surrounding marine plastics, but a less common example is urbanization and the problems of air pollution in cities, which impacts citizens on a day-to-day basis in their lives.

How can computational tools and resources be used to help speed up decision-making processes about the environment?

If we think about it as a value chain diagram, there are several layers to consider.

The first layer is data access: the availability of data, and the transparent access and use of that data. Nowadays, more than half of the world — including the global south and developing nations (more than 150 developing countries) — has near-real time, real-time or historical data access about the environment, which is a great milestone. We should promote this as a fundamental milestone because it is helping to substantially improve livelihoods, particularly in developing nations.

The second layer is data insights for decision-making and action: in different areas of the environment (air, water, land, biota/biodiversity, and oceans), having near-real-time or real-time data can help to support decision-making. For example, we have a platform called the World Environment Situation Room (WESR), where we provide a single-entry door to environmental data. The main purpose of the WESR is to make data open and publicly available in the way that one would in a situation room, as if we are facing an environmental crisis, which is the case. With the WESR, we can provide access to data, for instance, on monitoring air pollution with crowdsourced data from across the world at the very local level; at the level of cities, whole nations, regions, and continents; and finally at the global level.

A third layer, which is even more demanding, is data intelligence or data for the future, which focuses on a systemic way of looking at data and variables within a system, leveraging the bottlenecks and critical points to establish different scenarios, and then acting on them. Today, we have access to computing power and technologies to combine spatial data and sensing at the ground level and we have storage capabilities that we could not have imagined ten years ago. These resources are becoming increasingly available, and we are able to use these three layers in a radically different way than we could do in the past.

What type of data do you think that we are missing at the moment?

Accessibility and availability of timely, high-quality and disaggregated data is critical for accelerating the achievement of the UN Sustainable Development Goals (SDGs). However, there are substantial data gaps at the moment. For example, in 2015, Agenda 2030 and the SDGs were approved by all 193 member states of the United Nations. Since that year, we have had a data gap of around 45% for missing statistics and data from the 25 indicators that we can actually directly measure on environmental dimensions. This gives you an idea that even if we come to an agreement on data indicators and statistics, which are more or less 'official data', there are still large data gaps. The local level is where data is needed the most because it is potentially more relevant in impacting directly on people, places, and the planet, but that's the level where we are likely to find more data gaps. Today's technologies have been fantastic in filling parts of those gaps. For instance, we can use satellite imagery, sensing data and spatial data to complement in situ data at the local and Indigenous community level. The complementarity of geospatial satellite remote sensing analysis together with in situ ground-truth data provides tremendous capabilities that we did not have in the past. Citizen science has also been opening pathways at the local and Indigenous community levels and can bring the collection and management of data to a completely different level. In one project, we prepared a group of citizen scientists in a river basin in Sierra Leone to collect data in a very scientific, methodological way. I believe that we have new pathways for exploring methods such as citizen science that can bring good news in terms of filling these data gaps.

Geospatial data can be a fundamental asset for accelerating the achievement of the SDGs. It can be used as a cross-cutting enabler with

applications that transverse the five pillars of the UN: peace and security, development, humanitarian aid, international rule of law, and human rights. Moreover, acting as one, across the UN system (such as in the One UN Geospatial Situation Room), will be critical for successful attainment of Agenda 2030 and the future of humanity. In the coming months, we will lead an initiative that will provide a ´ONE MAP´ to be leveraged by the whole UN system (including more than 40 entities), as well as applications for humanity, member states, business, and civil society at large.

Do we have enough computational support to address our goals today?
We do not. The problem is not the potential of the technology itself, but that there is still a big divide in infrastructure and access, as well as capabilities. When we talk about the member nations of the UN and the SDGs, we are talking about 193 nations from which 100 are in the developing world and global south, and there are tremendous gaps in access to technology, as well as infrastructure, services and systems for access. I would say that there is a second fundamental element, which is development, meaning capacity development and building. People from the technology world think in terms of the triad of technology, people, and processes. Today, we have technology to address the technology portion and the processes portion of the triad, but we are very far behind on the people dimension. For example, we cover 60 countries from the five subregions of the global south with country data on the environment. The lesson learned is that we were able to create a fantastic dashboard with data analytics for those 60 countries, but we are limited by the capacity to analyze the data that we have in the dashboards, because most of those 60 countries have critical needs for capacity building in terms of analysis and management of the data, as well as gaps in how to translate the data into information and the knowledge that can be gained from it. The reality is that the impact that can be made on the ground is limited by these two interconnected factors: data analyses and capabilities. More specifically, we cannot address the SDGs from a general point of view because the priorities of each country need to be accounted for; for example, the priorities for Somalia (such as environment and security, climate change and water management) are different from the priorities for Colombia (for instance, extractives may be prioritized) or for islands in the Pacific such as Tonga or Fiji (such as disaster risk management), and all of these countries

also have varying degrees of access to technology and capacity to collect and manage data. In order to address our SDGs, we must address the divide in accurate analysis as well as in capabilities.

What do you see as the next multilateral sustainability policy that should be implemented?
One that is particularly relevant will be the successor of the Sendai Framework, which is focused on disaster risk management and the risks surrounding that, with particular focus on the most vulnerable communities and countries, such as the small island developing states and local Indigenous communities in the Pacific. I am sincerely convinced that in the future those areas will become tremendously critical, as we already have some indications through the Early Warnings for All Initiative that these areas will need to be central to the Sendai Framework. Unfortunately, natural disasters continue to be a fundamental challenge for humanity. Thus, the concept of multi-hazard early warning is fundamental because we need to be able to detect not just one hazard, such as a tsunami, an earthquake, a flood, or a drought, but multiple relevant hazards that can trigger each other.

Also, as we can see, pandemics are not only a health problem but also an economic, social, and environmental issue. Thus, I think there are also opportunities for multilateral agreements in this area that are fundamentally based on a Nexus approach, to bring together the five pillars of the UN. Of course, we already have a number of frameworks in place for tackling this, but I suspect that the next generation will need to be different, perhaps more agile and adaptive to vulnerabilities.

I believe that the world is becoming more complex, unstable, and uncertain, and these three characteristics of the future will likely advance the relevance of early warning tools and methods. In terms of future research, applications and foresight, I anticipate that new frameworks, specifically the ones focused on the SDGs, are not very far out of reach. We are halfway through the implementation of the SDG framework, so I suspect that the new frameworks will be radically different and will need to be more prone to vulnerabilities, enhanced for risk management and assessment, and more agile to include foresight methodologies. The reality is that most of these initiatives and frameworks are using mainstream conventional strategy methodologies that are poorly prepared for new risks or new extraordinary events. We could see that

the SDG Agenda was badly prepared for the COVID-19 pandemic, or the peace and security conflict situations that humanity is facing nowadays. The solution will be to prepare these frameworks with what-if scenarios and alternative pathways on the basis of those scenarios. Preparing frameworks in this way will accomplish the needed resilience and capability to be agile and adaptive to future events.

Going into COP27, the UN Climate Change Secretariat noted the disconnect between science and real action, which largely depends on government entities. What do you think is the cause of this gap?
I do think that some policies and frameworks are far from being grounded in reality. There still needs to be an effort in implementation plans to come more from a bottom-up approach, which means that there should be significant data shared between the common policy framework and the strategic action on the ground. That's one part of the problem. The other part is that, while most of the multilateral agreements are good in terms of establishing common transboundary issues – such as overall protection and climate resilience for the whole region of Southern Africa, which includes 16 countries known as the Southern African Development Community (SADC region) – some of these policies are very distant from pragmatic implementation of the needs and priorities of the countries: not only conceptually distant, but they are actually not directly focused on the needs and priorities of the individual countries themselves. The third issue is that there is much volatility in the political system. Some frameworks have a long-term approach whereas the political cycle is constrained to a four-year term, so politicians are much more interested in short-term, clear, and political solutions, and when it comes to the application of real action on the ground, there is not much political will to put that into action. Science is clear, but the actual action to do things is very different.

Some scientists may feel that they won't be able to enact real change with their research because of this gap. What advice do you have for those researchers?
One area that is very important is the public understanding of science. The way that traditional research communities and scientists used to think about science as a detached corpus of knowledge about a certain topic might need to be adapted to improve communication and outreach within certain communities. Today, we are much better at this than

we were two or three decades ago, but there is still some connection to be made there. A good example of this is citizen science, where we have capabilities on the local level to use ground-truth data from local communities, and sometimes even Indigenous communities. That kind of data could be considered by some as far from the scientific approach, but how we can bridge these different worlds needs to be clarified. There needs to be an effort by scientists to touch base with reality, meaning with the general public. It's not enough to say that science is right, because it's not well understood by society.

Other than enacting stricter policies, what can be done to ensure that we keep 1.5 ˚C of warming within reach?

If there is one system that is most closely related to the triple climate crisis, it's energy. Understanding the symbiosis between energy systems and the environmental world is critical. To be realistic, in order to reduce the carbon footprint in the coming years, before we reach the year of 2100, we must have climate adaptation and mitigation. The carbon footprint of one of the most extensive globalized industries (the energy sector) is yet to have a symbiotic progression between fossil fuels and renewable energy resources. The plans for fossil fuel investments of some of the biggest energy companies in the world are three times larger than they are for renewable energies. This means that it may be naive to expect tremendous progress or improvement in the control of the 1.5 °C goal. A more

realistic number may be 2.5 ˚C or a number of scenarios between 1.5 and 2.5 ˚C. Another solution is to look into the systems that are interconnected and interdependent so that when one approaches the problem, they aren't just approaching from an energy, food or socioeconomic point of view. For example, many countries in the global south have fossil fuel dependencies from oil to natural gas that are going to be present in their socioeconomic systems for 80–100 years. It is then likely that we must adapt policy and climate change mitigation strategies accordingly. To expect that carbon, oil and natural gas dependent countries are going to radically shift their natural resource base and industries quickly is innocent and can be ineffective in terms of approaching the problem. Instead, having a systematic approach to reality might be more effective and impactful.

What are your thoughts on the importance of taking a 'partnership-driven' approach to addressing the SDGs? How can these types of collaborations bridge different scales of policy?

I tend to look at the 17 SDGs as one goal: humanity. The difference between the SDG framework and its predecessor – the Millennium Development Goals (MDGs) – is the systems approach and interconnection across the different goals, as well as the acceptance of a transformational approach in which different member states can adopt the framework at different levels according to their priorities and needs. I believe that a common trait of the

SDGs is the focus on people, places, and the planet. If we approach those three principles together, there's also another piece that is critical, which is partnerships. Partnerships are the mechanism for making the goals possible. It would be impossible for an organization like UNEP to act with a normative approach on a global setting. To produce impact at the local level, if we do not partner across sectors with other agencies that are working on the ground at the local and sub-local level – such as the World Food Programme, UN Refugee Agency, Food and Agriculture Organization, Human Health Organization, and the UN Development Programme – then it would be completely impossible to deliver on the SDGs.

Another way to look at it is in terms of upscaling: you can never upscale the impact of any action if you do not have partnerships. We must always think that the private sector is better positioned to work together in partnership with the UN because they can do things that we are not able to do on the ground – for instance, they have access to different kinds of technologies and modalities of funding. The same goes for universities and technology centers that are fundamental as centers of excellence to take action on the ground level. Overall, it's not only partnerships at the local, regional, and global level that are important, but intersectoral partnerships as well.

Interviewed by Kaitlin McCardle