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AI + Satellites AI + Satellites.

>> STUART RUSSELL: There are some seats over in the far end there and also in the back row, one in the back row there. Great. Okay. Thank you.

Welcome to the AI + Satellites data session. I'm Stuart Russell. I'm looking forward to a really interesting day today. Just to remind everyone, you can log on to pigeonhole and the password is AI for good 18. That will enable you to upload questions we can get to in the discussion sections.

We have basically the day divided up into 90-minute sessions with breaks in between and lunch. The first session today, we'll have our five speakers, and if we have time,ish there will be discussion at the end. Let me just get right into it. This is a quick reminder, I made remarks yesterday, some of you probably already saw those. Just in case you didn't, there are lots of satellites up there producing a huge amount of data and roughly speaking we image the world every day. I say we, they, not me. The resolution on average, some of it is even better than 50 centimetres, bullets take that as a representative figure, when you calculate the amount of data it is two times 10 to the 15 pixels a day or roughly 2 billion

megapixel photograph images. From that, if you tried to store that, it is about 100 million a year of disk space. We're still some way from having global infrastructure of the kind that we have, for example, for weather. With the weather, if you want to ask what's the weather in Geneva today, you type it into your phone, it tells you what the weather in Geneva is today. That's a result of an enormous realtime infrastructure involving satellites and enormous computers and storage facilities and governments and corporations all working together to do that. We do not yet have that for visual satellite coverage of the globe. One could imagine what it is like if you had where you could just say how many camels are in the square today at the market. You just type it in as a question. It tells you because someone has already imaged the market and counted the camelser o some computer has counted the camels in that particular market square and they have done the same thing for every question for everywhere in the world all the time.

That would really mean as as super power, not like stretching out your arms, legs to arbitrary lengths like elesta girl busying the entire world at once, seeing all of it. Something that your brain -- even though your brain can cope with the volume of data, your brain can't copy with that complexity of data. With the aid of AI, satellites, it will be as if you could see the entire world at once and everything happening in it. That will be cool. We're still some way away from that.

If we have that, we can do all kinds of things that will benefit humanity from predicting major events like famines, explaining past events, learning how the world actually works, learning of the earth systems, and the potential is really amazing.

We're just really starting I would say on the intersection between satellite imaging, geospatial data analysis and AI. Here, for example, it is the early results of a collaboration between digital with datasets that are ground truth, counting houses here and it looks like this is pretty easy, just rectangles, you look for rectangles in the right size and those must be houses and it turns out it is difficult, in the real datasets we're getting 50% accuracy. There are lots of rectangles, they look like houses but they're in facts tombs. You don't want to count dead people in the population count but there are rectangles and cars and parking lots, this is some data from Jimmy's company. There are rectangles that are container, containers in long lines which actually are trains and you want to differentiate those kinds everrer things and there are rectangles and you want to guess what these are? These are recreational vehicles, this is a large RV park in

Arizona. Theses are homes and they also move.

This is just to illustrate that the challenges of interpreting satellite data is not just looking at a pixel, deciding if it is tree cover or ocean. This is a much more complicated task that combines computer vision and AI, machine learning and real common sense understanding of the world in order to actually realize that global realtime database.

Our speakers today, we have a pretty amazing line-up of people. It nazi is the manager of UNICEF, the United Nations -- I won't give the entire name, the operational satellite application arm of the U.N. Mark Doherty is head of earth observation in the European space agency with a long history of putting up major satellite programs. Andrew Zolli is the vice president for everything good that planet does, they have the numerous satellite fleet up there now and Andrew is in charge with doing good things with that satellite fleet.

Jimmy is a long-time AI person. I have known him for probably 30 years, something like that.

He had a career at NASA and since then he's been through several companies that extract useful information from satellite data and started insight and then David has fantastic connection between satellite data, environment, resources, object. I'm looking forward to the presentations.

As we said, upload the questions during the presentation or just put your hand up at the end and we'll have a discussion. We'll do it in this order.

>> ELENA ALTIERI: Good morning. I'm managing the programs for training and research.

I wanted to say, to take a step back, because I believe that this business, the earth observation business so far hasn't really proven its case. I say that as a big hand over at the big hand of satellite imagery. If you look at the space businesses, the communication, of course other let's say IT services around positioning systems, and they're fully integrated into society today. Yes, to some degree earth observation is weather forecast was mentioned here, it is there, but we're not really seeing the big impact from earth observation from satellite imaging that we would expect after all of these years. Wouldn't it be great if finally the technology, the fusion of technology advances in technologies, it could make this happen. Wouldn't it be great if you had satellites that could provide free and open access data, powerful algorithms that could provide the right information to the right countries, people working in the government sector when they need it. That's why I'm really excited about Artificial Intelligence. I strongly believe that this technology may finally be able to put earth observation to

really, really good use at the national level and with a new focus on the 2030 Agenda for Sustainable Development, there is great synergy potentials coming out.

I wanted to say also, is that sat lie imagery, with global -- this is important -- a lot of data are collected locally and in an uneven manner. Satellite imaging, the beauty of it, hey, you have global coverage. Here we have global initiatives, we have global goals, the Sustainable Development Goals, there are 17 of them, you probably know there is 169 targets, 232 indicators, all which satellite imagery can help in a lot of cases. That's why finally now we have a great possibility to combine these technologies. The global goals are really about letting countries grow and meet their targets so that basically people particularly in Developing Countries will have much better lives. This technology can actually help towards it, towards doing that. So far, what we have seen, the business has been very much focused on individual satellite images. You purchase the satellite image, we download one, you use the processing and analysis on it and you get the information. That's fine and that's also why it hasn't taken off. It is cumbersome.

Fast forward, look at Netflix, look at Spotify. Streaming music. Although I love my old LPs and putting them on, it is quite cumbersome if I have to have the whole world's Jana Nemcovicova library in my living room. I would love to have that, but at least now I have Spotify, music, whatever have you. I can get access to this information. If you can do the same with satellite imagery, streaming directly to the Developing Countries to the people working in the public sector that needs to know the latest forest cover, needs to know the latest in agriculture production, et cetera, then we can really start to have a big impact. I think this technology has great potential. However, it has to come with capacity development and that's also a big focus on the use of technology. Don't think because you have great technologies that things just happen by itself. You also need to combine that with awareness raising, capacity development and training at the country level. At UNICEF, we have been doing this for 17 years, not Artificial Intelligence, but we have a team of experienced analysts that have been analyzing satellite imagery and training people using sat lie imagery for a long time, we have been training Member States, sister agencies, NGOs and international organizations. It is very important in terms of a Sustainable Development Agenda that we include everyone, including even private businesses in terms of training and making them more aware of how they can benefit from this technology.

We also have the benefit of being powered here in Geneva, a

bit outside of town, and we're fortunate to have IT capacity. It is another aspect of this. It was mentioned huge amounts of data collected daily and it is a huge amount of data being collected by and they're pretty good at big data processing and Artificial Intelligence. We can also bring in the great lessons learned from other sciences into this. I think we have a great potential of making a big impact as a community. The data and analysis that we have done at UNICEF over these years and are available, and we have done a lot of vector instruction, plots from refugee camps, natural disasters, earthquakes, et cetera, this information, it will be put out for AI specialists and machine learning specialists to take advantage of and match that to the imagery that you can then use as training datasets in order to have much better information and better algorithms. I want to highlight this, I think we're today at the stage and you can see that for many presentations today this amazing technologies that could actually change the game here. We have today the potential for making a tremendous impact to especially Developing Countries and the greatness of the technology again, it is that it covers everywhere, it covers the smallest island in the Pacific, it covers Switzerland. It shows that it can cover large areas, cover all the confidence at different resolutions and we can Zoom in to the finest 50-centimeter and below pixel in the smallest Pacific island and also extract information from there. That's why I'm so excited about being here today. That's why I think it is so important and timely that ITU organizes this event and really looking forward to it and as a community, work well together, they can really agree to be a part of that.

Thank you for your time.

>> Before I start, I would like it thank the Chair for promoting me, I'm an adviser to the guy that wears the hat of the subdivision. Can we go full screen? Great.

Based on the messages, the Sustainable Development Goals, earth observation, satellite data, it is necessary, it is interesting to see how the SDGs could be achieved without using this type of information. There is a tsunami of satellite data coming, but both the opportunity and the challenge, and AI for earth observation has huge potential. I have to say I'll talk more about data and the opportunities and people in the earth observation business who have been doing this stuff for years, there's a certain degree of skepticism and the message there, we don't have to use Artificial Intelligence, things we can do perfectly well already, we have to understand where it could actually help us do things that we currently cannot do. Actually what I'll finish with, it is more pointing to an active area of research that really could enlighten a lot, even the

setting of the Sustainable Development as a whole, how the earth system works and how it makes sense, not of the satellite image, but information and key parameters, other issues.

First, someone talked about the fourth industrial revolution, well, space is going through a revolution from astronomers, international cooperation with the space station and I guess the question that the public asked is what's it doing for me, actually it is doing a lot for the people even without them knowing it and the focus also in space agencies is to deliver the benefits, the space commute. Stewart was saying there are lots of satellites, this is satellites of the 50 kilograms class and above, and what it basically shows you is that we're launching maybe 10 a year, government is having 10 a year up until 2015 and we now have an explosion and this doesn't even include the class of satellites that Andrew will talk about. You have to be careful on satellites as well. Also in terms of there are lots of satellites with different capabilities. The drive is entrepreneurial business. Space agencies like NASA, NOAH, for a long time they have been -- even the rational for government to put the systems up, the Sustainable Development, it is climate action and more recently Disaster Risk Reduction and moving just to put things in perspective we wouldn't actually understand what's happening with the climate if we did not have the earth observing satellites and that's absolutely proven, its ability.

Space agencies are working together and they basically -- there is a group that's been working with the earth observations and they have identified six of the Sustainable Development Goals that earth observation can make inroads into. I guess for all of them, satellites can contribute and these are the six and they're kind of obvious, life on land, life below water, reducing hunger, sustainable cities, of course climate action. You can map those to not only the goals but individual targets and actions are being taken on each of those. I think we'll hear some of those later.

As Elnar Bjargo was saying, it hasn't necessarily reached its full potential that. will come soon. There's a list of obstacles of people trying to use this data have pointed out. We were just discussing with Stuart this morning that people with computer vision suffer from the same obstacles. I'm here to tell you that a lot of those obstacles, they actually are gone and let's say I'll step up and say boldly that the European Union, it is not a super power but it is addressing a lot of issues that the previous two speakers have solved and I would say on the international scene it is not bragging to say that Europe is really leading in global monitoring. It is a commitment that backs European policies. That's the programme.

We don't have all of the colors up there, this is an 8 billion euro investment in a public infrastructure to monitor the planet, and it was originally called global monitoring for environment and security and that probably better conveys the purpose than the capurnicous which is more catchy. This system is designed specifically to meet government policies, sentinel to the multi-- we have worked for years to make sure it could be used for national mapping of forests to support the climate policy.

What I should say, it doesn't do 50 centimetres since we're doing global and national monitoring, we do 10 and higher. That meets those needs which leaves a lot of space for commercial operators. The key thing here, this is a policy of free and open access. What's it mean? Whether you're in Tanzania, Italy, Mexico, China, you can go and download entire coverage of your country for free every two days. You can do it with multispectral and you're familiar with that, you can do it in ER, you can do it with an imaging tool or the atmosphere free. Simple message, take it and use it, that's a huge step forward and it is a very important step for people in Developing Countries in terms of access the issue is how to overcome let's say the skills and capacity building that's necessary to help them use it.

The tsunami I have mentioned, just to give you you with all of that data, up until 2015, with all of the the archives of the unit, it was 10 terabytes, since we started to launch the sentinels we're degenerating more than 10 a year and there is plenty more where that came from. These systems, they'll be up for decades, not years. It is not about individual satellites, it is about monitoring the planet and deriving the information from the observations.

There are some numbers in terms of not just the data growth, 53 terabytes of data downloaded by 120,000 users worldwide, those are -- many of them, most I have to say are in Developing Countries and there are significant use in Developing Countries and we're really cooperating, for example, with the development banks, U.N. in-game, agencies that stimulate that use.

Some of the most frequent applications for users, the agricultural monitoring. Here is an example, this was done by a research fellow, finished about a year ago, what I would like to point you to, in order to generate the first national crop map in Germany, it is 30-meters in satellite data and Germany is an advanced country, a lot of skills in using this data, actually 1.7 million field parcels had to be used to train up the system. That's no small exercise. If you're doing that in Germany, you took some time, we're working with European Union countries to

get this type of data used in the common agricultural policy, we're working around Developing Countries and here is an example where it is used just for crop area monitoring, but the issue is we do not have anything like the same quantity or quality of data. Machine learning techniques can be useful here, particularly in Developing Countries where you don't have larger fields with single crops, and then you have mixed crops. That can be better suited. The question is, can we exploit this, this data, with less quality data in Developing Countries where frankly they need it most.

Here is an example of results from the satellite we launched in October last year. You're looking at nitrogen dioxide concentration worldwide, that's the gulf regions and then Mediterranean Europe, that is all of the industrial pollution, you see Barcelona. We go down, we have a look at -- you see over Africa, much less until we get down to South Africa, around here, some emissions. You will see dirty New York with a lot of emissions. That's -- that data is daily. We monitor that daily. We'll launch another one, the fourth providing for Europe, Africa, euro Asia measurements every hour to get the dynamics as well and we're using machine learning algorithms for the retrievable of that. This is about an approach from the Norwegian system, they can detect ships and they say that the ship tracks and then they compute the emissions. If you put these things together, you actually get the global picture of air pollution and emissions. This is the same systems, they're measuring ozone, carbon monoxide and greenhouse gas. The future requirement for this type of observation, CO2 global to to support the Paris agreement and particularly the global stocktaking. I'll stop by saying these techniques, this sort of approach, it is what is played, but it is actually hugely more challenging in terms of the technology and underlying science to reach it.

We have been -- when it.

Coulds to AI, there are examples with AI being used, but what we want to see, it is actually AI being duo employed, can it be deployed to really massively enlarge the use of that data that these pedbytes are generating information in the countries, it is in the hands of people in the field in the floods. If we consult with the research community in Europe and industry, they're telling us that in their view there is a number of major actions that need to be taken and no project, no individual research that could be done on their own. Those are the big points. I would highlight the need -- they're telling it us the need, the data ecosystem that's universally equipable, not to one satellite, a project, that has the training data necessary. It is a lot easier to get satellite data than it is to get the

quality data which today are previously called validation data, it is very expensive to collect and it is done over chosen test sites and if you want agriculture, you go and ask the Ministry of Agriculture in Switzerland to give you their data. It is not something that's given away free. So this is harder to get and in addition, coming to what Stuart pointed out, the difficulty for people to use satellite data, there is a whole discussion on something called analysis-ready data and it involves corrections to data from different sensors and we have the optical so that they can put it altogether and access to the data.

These are huge challenges. Another fantastic opportunity that I won't go into detail, it is putting AI into orbit. Autonomous systems that can make decisions on their own, one satellite sees cloud, another satellite that's coming afterwards to look through the Cloud and these sort of techniques. First uses will certainly be for data reduction in particularly with the new hyper spectral systems. This is basically leading to a new architecture in space.

I want to finish just to say -- to give you a sense of what it is about. It is not about satellite images but information about the planet on all scales and this is a series of parameters derived from a whole series of satellites. If you take each of those parameters, you basically get a data, you have the coverage of whatever scale you want with variations and then you're seeing the temporal signals and the way it is presented you see primarily the annual cycle, the seasonal cycles, and you remove that to get the anomalies and you're focusing on global primary production which is carbon fixing, photo synthesis at the root of the link chain, you see the root to the SDGs. You see that type of information that's available over oceans, and when you put all of the different sensors together you get just the observation, amazing information on what's happening at the planet over time and the power comes when you put all of that together. The traditional way information like that is used is had with models of the system and data assimilations, but actually there is a lot of patterns and signals in there that model today don't capture. The real big challenge is how do you put not just AI and satellite data, but AI, models of the planet, observations together to identify the signals, model them, potentially get predictive power which somewhere more than we can get with the models and the observations today. This would be a massive breakthrough if we can deploy the technologies to address issues like this. It is a lot more important than counting cars at JC penny's car park. It is about sustainability of the planet and the earth system.

Finally, in short, I hope I have demonstrated in these few minutes earth observations and working towards the Sustainable

Development Goals. That's a no brainer.

The real challenge, can we use -- AI has the potential, but can we use it to extract the information and deliver on the full benefits that all those observations have the potential to yield.

Thank you.

>> Good morning everyone! How are you feeling today? Good. How many people here, just by show of hands just so we can calibrate, how many people in the course of their work have looked at geospatial data. We know who we're talking to.

I want to say thank you to our wonderful colleagues. A thing that I want to suggest is just the remarkable ways in which programs like the earth observation work and the work of the E.U. and NASA and in my own country, the United States, the federal science agencies, they have created these extraordinary public goods and in the the process of creating the public goods, the way in which creating the public goods puts pressure on this new and entrepreneurial way of space actors to follow suit and to interoperate and to really support the critical global goals. By way of quick introduction, I oversee what are global impact programs of the planet. My teamworks on humanitarian response from around the world, we work on Sustainable Development, all of our scientific research and development programs of all of the work we do with the scientific researchers around the world and many others.

Today, in the interest of complementing the great overviews that you have heard already, I thought I would just talk very briefly about a couple of specific examples, a couple of ways in which we're beginning to look to calibrate our work and support a very specific SDGs and particular indicators beneath them. Is there a practical way to look at how the tools could be used.

In order to do that, we tell you a bit about the planet, it is understanding the technology, not a sales presentation at all bop just to give you a sense of how we work.

Our overall mission as an organization, we're founded by three NASA alum with the overall mission to use space to help life on earth. Within that, we have a series of enumerated missions, numbered missions, the first, mission one, it is to image the whole earth every day and to make global change visible, accessible and actionable. I'm happy to report that especially the first part of that, imaging the earth every day, we accomplished that last year with our current area that we'll talk about. We do that with a large number of very, very small satellites. This is well outside of the realm of the scientific programs and earth observation programs but as many of you know, earth observation has a long history in relationship to the military and intelligence gathering and defense and as a

consequence there is a lot of satellites named for bird of prey, beaks and talons, so our satellites, they're named for birds of peace, doves, 30 centimetres long there, you see it is covered in artwork, all satellites, we have artists in residence that actually -- we work with communities around the world to design all of our radoms and launch vehicles we contract on and all of the devices themselves and everything we do, we look to create social engagement and the humanization of space so that we see its a collective part of our common heritage.

What we do, we put them in a specialized orbit, this is a bad visualization of the orbit because the earth itself, it is actually in the wrong relationship to the sun. What we do, we have several hundred of the satellites that are in the sun's orbit and we say if you're the sun, here is the earth, rotating every day, here is the spin like this, as the earth turns underneath them, we image the whole earth every day at roughly -- at more than 3-meters per pixel. That's not enough to read the newspaper obviously but enough to see -- essentially to see the crown on the earth every city, every field, everywhere, every day. As you see, we collect that information, actually now we run three component systems of the larger constalation and the first is 180 right now and continuously being grown, a number of these satellites. We also operate the rapid eye constalation and we have 13 and soon to be 20 of the sky satellites that image between 70 and 80 centimetres per pixel, that's an extraordinary amount of the sub meter capacity and the two systems, particularly in the middle and the one on the right, they interact with each other. We're imaging the whole earth every day, we're looking for patterns and thresholds of change in systems and then triggering the higher resolution assets when we need them. The idea is that these two -- we're looking continuously at the whole earth and then beginning to automate the process of looking at particular patterns and forms of change as they occur. You cannot do that over the long term, unless you make the shift that's described earlier, putting AI in space. Otherwise, what you do, you download all of the data continuously. If you don't have some intelligence in the satellite, that's an area where I think there will be significant change.

The other thing about the planet, we're complete end-to-end system, we envision prototype design, deploy, manage, download the data from all of the satellites and put to the in a Cloud-based system and make it available to all kinds of common actors. The broad premise of this work, it is to allow us to continuously monitor the earth, to discover trends and patterns upon its face and then deliver derivative insights and you will hear I think in a few minutes some really remarkable examples.

I'll focus on two.

A thing I'll show you actually before I show this particular example, it is just to give a sense of where we see the larger opportunities, it is to first begin to look at taking those patterns and beginning to make change on the earth legible and highly usable. Here we have great partners and many organizations that are domain experts that help us understand specific forms whether they're in the understanding of the signature of natural disaster, working in agriculture, working in humanitarian monitoring and response. I'll give you a quick example, this is done with a partner of ours which someone here is clicking on is a solar installation in China and because we have indexed all of China, this is an index of our data on the week, we're able to find every single solar installation in China that fits that rough spacial pattern. That's valuable if you need to track the process or energy investments to issue go you an example. Let's imagine, we didn't do this exercise on purpose and we don't do it in public, we replace these particular tiles with refugee camps, for instance, we're actively and privately and very conscientiously working on similar systems that track the growth and progress of refugee camps in highly conflicted areas to help U.N. agencies provide operation support to refugees in the environments. In fact, the Chinese, it is interesting here, they realize that now the solar installations are Vicki Hansonable from space and they have designed them from ways that could be seen in the satellite imagery itself. That's really cool.

If there is one thing you take away from the few minutes of remarks, I want to share the basic mental model that we use continuously to guide how we think and where we think things are going. We call it the four Is, that's because each word in English begins with a letter I and it has to work for engineers that are very literal people sometimes. Here is a sense of where we think innovation is occurring and where we think it will occur. Down at the bottom, as you have just heard, there is an explosion of information, it is a very uneven explosion. We're seeing extraordinary amounts of new earth observation data which is wonderful. Not the same explosion in highly accurate, labeled round truths, terrestrial data that would allow us to correlate the patterns you're seeing from the space from the patterns you see on the ground. Critically, it is critically important, if I stop doing work I would do today, I would immediately go and work just on that problem because I think it is -- it has the biggest bang for the Buck. There is enormous amounts of information, so much information that there is more than we could possibly pay attention to. As a consequence, we're Burring the signal in all kinds of information and

extracting the signal, correlating it, providing deep insights about it, it is a real challenge. There is a second revolution that's concurrently underway and that's the insight revolution, that's the machine learning AI, computer vision and basic statistical analysis. Many of the tools don't require AI. The thing I'll tell you, overwhelmingly today, this is an issue for any of you that work in AI, it is overwhelmingly supervised learning. There are interesting deep learning approaches that apply to the images that are slightly different in characteristics and I won't talk about it like we do in the Q&A. We have this -- this is where the action is. This is actually, you know, satellites at the bottom, AI at the top. That's what's happening in the two layers. What's happening up above them? If you can extract consistent insight from a continuing refreshed imagery stack and you can begin to produce something new which we think of as a big indicator. We believe that the era of big data will be sur planted by a coming era of big indicators. Doesn't mean that the big data era is going away but we'll have continuously refreshed realtime analytics about many of the earth's most important ecological, social systems. That's a fundamental shift, the ability to continuously monitor and to build a reliable indicator is exactly the kind of thing you need to do the last level of the market, and that's to build new instruments. Here we mean new technology, policy, especially new kinds of financing instruments. In part, because there is not often enough public money to cover the challenges we have to confront. We have to figure out new ways to connect the private sector whether it is through insurance, through the issuance of the financial instruments into the systems that we care about the most and are the most essential for the continuation of life on earth.

Down at the bottom, there is lots of information, up at the top, there is more value. We're all collectively moving upwards of that stack, a lot of energy, information, it is about what's new and possible at the bottom but very soon we'll talk collectively to all kinds of constituent.

I would like to give you an example -- I don't know if you want to take a picture of that. We find this extraordinarily valuable, often we talk to people, the instrument layer, we say where do you live? What are the criteria we need? You help us design a new indicator, U.N. agency, et cetera. So let me show you two examples and I'll close with these two of places we're actually doing the work towards indicators that could be used during the period of the performance of the SDGs to actually drive behavior. The other thing to understand about this, it we'll be making shifts from retroactive analysis, looking in the past to increasingly realtime and increasingly predictive

analytics. We're time shifting in our effort to try to bring information into the human decision making cycle. I'll give you two examples of this. One in deforestization and one in cities. The first one I want to talk about, it is goal 11, just to refresh everybody, if you have not memorized all 17 of the goals are to make cities inclusive resilient and sustainable. This is a real challenge. As many of you may know, urban growth is roughly -- there is a long period of time when you're essentially a small and sort of village-scaled community, if you urbanize, things hit a tipping point and they rapidly take off and things are vertical for a while and they level off. The growth doesn't end, but it begins to slow again. The challenge, it is really in that middle period when things are growing really fast. Often cities don't have the infrastructure to keep up with their own growth. Here I mean the governance, the planning infrastructure. If you don't know where growth is occurring, you can't get a handle on what's happening, you can't put in place taxation to fund disaster risk production, to fund Public Health infrastructure, et cetera.

A good Example of this, this is a picture of tans. This is particular kind of growth, it is low and largely unplanned, that he is to say you don't see grid-like structures, you don't see the typical urban planning structures you see in highly developed cities. As a consequence, a lot of this growth is invisible even to those that live there.

Here is an example of us looking at the 3D imagery. I apologize, it is -- the imagery, it is a business crisper than the monitor, the monitor is blurry. A thing that the World Bank invested in, this is the power of ground truth data, it is a highly accurate labeled training dataset in open street map of all of these buildings. What you're looking at here, this is ground truth data that's enormously valuable. We then go in to do training algorithms to train the satellite imagery, to train on the satellite imagery, having this data, it is valuable, here is the first paths and it has gotten better since this slide was produced at the algorithm's effort to meet the dataset on the ground, so we're trying to find the pattern in the imagery that best correlates with the material that's on the data. Once we have done that, we'll skip several levels, we'll do things that are interesting, way out on the edge of the city, where the city is growing dramatically, we can begin to monitor this in almost realtime in ways that actually allow urban decision makers to actually guide their behavior it is important to know the growth, we don't know what it is but it is estimated between 8 and 15% a year. It is growing so fast actually that all of the local forested -- the forest reserves, they have -- there is no trees in the forest reserves because all of the needs to build

the city. In the process, it actually changed the flood risk for the principle river system that runs through the middle of the city and it changed the flood pattern. These systems interact with each other. Here what you're seeing, it is around February, or this is May, 2017 to February of this year, what you have there is the growth. You can really see it if you look up in this central portion of the image, you can actually watch as new construction is built. Now the important thing to say here, this is a statistical model we're doing. We're not capturing every single building. What we're doing, we're capturing the pattern of growth to allow people who work there to target where they go to do the additional work, the additional on the groundwork, and as you see, it is quite something, over just a few months. Actually the algorithm is better too than where the buildings appear. The second thing we do, we then take the higher resolution assets, where we identify the growth as occurring and we take several pictures of the same place from different angles like the eyes have different angles on two-dimensional images, two 2-dimensional images we reconstruct 2D from, we fly over, take pictures from different places and we reconstruct the 3 dimensional structure of the city allowing us to understand the overall liveable floor space in the city which is the indicator that we want to understand best than folks on the ground will understand the best. The second example I'll give you quickly, deforestization, goal 15, to promote the sustainable use of our ecosystems, particularly in managing our forests. A challenge, the forests, they're so big, the areas we care about, they're so large, that they're almost impossible to monitor, even from the air.

This is a classic area of earth observation which we're bringing a very dense series of time series analysis. I don't know if you see this, this is deforeresolutionization in Bolivia in 2015. Just a couple of months, you can see this enormous amount of deforestization that occurs in an area with no other human habitation. What's really important about this, this little line down here, it turns out that it was the road that people put in before they take the assets out. You have to put in a road to take the stuff out. When we see the roads going in in from space, we have looked at partner organizations hundreds of thousands of h the ectares of wooded forestization because we caught people just before they were to act. It was a complete shift rather than looking and saying what happened, whether than saying what's the indicator of the stuff that will happen. The other way to do that, we take the earth observation, we partner with an organization based in the Carnegie Institute of Science and they fly very sophisticated hyper spectral, multispectral and light our systems over the forest area allowing them to

understand what's in the forest canopy but volume wise how much forest there is. From that volume analysis we get Biomass and from that we get the carbon. We build AI machine learning algorithms that correlate the carbon assessments to the satellite imagery which was continuously updated. As we look in that very same system and you see the deforestization, for example, it is up in the corn, you begin to calculate what the carbon emission was for each pixel of deforestization that you scourerring. You see the example I showed you, it is way up in the left-hand corner, this is the actual system. In to the process, we can get the indicator of continuously changing measure of forest carbon. There is a kind everrer thing that you build new green and financial instruments to link private sector investment and provide reliable indicators of what's happening under the system. I'm not going to spend a lot of time on this. I hope we can have a conversation about it later. What I want to say, my big message, it is we need a data strategy. We need an AI strategy. For the U.N. system as a whole, right now, it is highly fragmented, it is highly -- it is happening in pieces, happening at a lot of smaller ways. We need it happen in a bigger way. In a much more organized way, in a way that brings in all of the different ground truth data, satellite data together in a place where we can all work on it as a collective common good.

With that, I say thank you very much. It is a pleasure to be with you. I look forward to the next session.

>> Good morning, everyone. Interesting to be back on the podium with Stuart, I met him when I was a freshly minuted graduate student and didn't know what way was up. It is deja vu to be back together again. We have talked about the work of AI to interpret the satellite imagery.

As the previous speaker said, we're in a golden age where the number of satellites going up has reached this rate where we're doubling everyone to two years. This creates as they have said, this is a weird bottle neck where we don't have enough people, we did a calculation, you want to look at the earth every day using satellite imagery, you need 8 million people doing nothing every day but staring at computer screens. It obviously won't happen. Even the NGA in the U.S. won't fund 8 million people to stare at computer screens all day for satellite imagery. At the same time we're in the middle of an AI revolution, where deep learning actually works. Having been in the field for 25 years, it is amazing to me that now I can take a new problem like detecting airplanes, detecting real cars, detecting planted forest, Virgin rain forest and hand it to the team and a few weeks, months later they come back with an algorithm that's precision and recall. We take that for granted

very quickly and I promise you having been in the field a long time. That's new, it is incredibly powerful.

We now have the ability to build buildings, detect cars, find oil tanks, figure out how full the oil tanks are to find new houses to track land use change, to find shifts and planes, it is a very long list of things we can do. So now we have this embarrassment of riches, we have the satellite -- we have the world every day and increasingly finer and finer resolutions, we have the AI that let's us find objects and track land use change, the question is how do we take that, make it useful and so the mission statement for this is to understand what we're doing on the earth and we sell across -- we sell to folks on wall street making investment decisions, insurance companies trying to decide insurance rates and disaster recovery and we work with humanitarian agencies on other problems. What I'll do in the brief presentation is to give you a worldly tour of some of the things that can be done in today's world with computer vision and satellite imagery. Obviously in major areas of land use, this gets out problems of poverty and deforestization and problems of development and it is also important for investors and for folks like the World Bank. It is quite amazing the results we see. We have been working with both planet resolution and the finer resolution from folks like digital global air bus and even with the imagery from planet I can find roads and here you see more of an official map and in the left, the corresponding Road network we get from the satellite imagery. There is a huge number of roads in a lot of the areas that are not on the map, that are not even in the open street view that we can pull out by using an AI approach. In particular, we have been looking at certain rapidly developing areas and look over time and we can see the rate of growth development, building development and start to understand both the environmental implications and the social, economic understandings of the growth.

On the deforestization side, an interesting problems that comes up, we'll talk about this more this afternoon in the deforestization section, there are actually a lot of managed forests and if somebody is managing a plantation and they go in, they harvest that, it is not deforestization, that happened 20 years when they cut down the forest and built this plantation. A thing that we have been working on with the global forest watch folks is training AI algorithms to separate at a fine-grain level between Virgin forest, managed forest and other things like urban areas and water and all that as I say, it is trainable in a 3-meter level image from the planet cosnstalation and we can go down to managed forest, you know, urban areas.

On land use, the other area that's relevant to some of the

of the development goals, fighting poverty, we have an ongoing collaboration with the World Bank and previously we looked here and used recent surveys of poverty in Sri Lanka and looked at obvious indicators like a car density, building density, building height, the crop -- the productivity, which I come back to later, they use that as to create areas for poverty, the folks there, nice results in the academic literature showing how the different satellite-based predictors correlate with that poverty. The last year we took a step forward and started to look at all of Mexico. They were investigating a really interesting more aggressive approach, going directly to the neural network and basically training the neural network from the poverty rate itself. Rather than telling the neural network, telling the AI that car density is related to poverty or building roof time, it is related to poverty, we give it the imagery and all of the spectral lens and give it the poverty rates for each neighborhood and try to figure out which features are in the poverty. The early results of the first year of the project, it is not as good as the human-derived features but it is not atypical for early work on deep learning. We believe that over time this is a better way to extract things like poverty rates from satellite imagery and predeciding what the futures would be.

On the disaster response side, this is an interesting application, it involves so many satellite -- when hurricane Harvey was going to Houston, we went to all of our partners and we asked them all if they could do whatever they could to get imagery in Houston and we had ongoing collaborations with both the U.S. government agencies as well as multiple insurance agencies around the world and it was the best data that came from the radar satellite but we also used digital imagery, the planet imagery and the acemetry, other sorts out of Italy and we put it together using digital elevation maps to produce a full floating effecting depth map for Houston and the good thing about this business, the insurance companies paid us immediately for the data and we were able to give it to the State of Texas in their work to figure out how to come back for future hurricanes and reduce the flooding in the future.

We have looked at many other things that are economic and social good, and there was a chemical explosion about three years ago, it had an interesting be affect that it blew up 100 million worth of automobiles sitting on the dock waiting to be exported. This is obviously not good for the people involved but it was also a very unexpected risk factor for insurance companies. Being able to track simple things like how many cars are on the dock that may be in proximity to dangerous chemicals is an interesting sort of emergent property of our complex

economy and it is important for many players to understand and it falls directly out of the analysis of the satellite imagery of of the areas. Basically, the highest qualifier risk is from the top of the hill surrounded by trees and those trees and vegetation, it is dry in the summer and that's the highest risk and the concern for the work, it is what I described as my house in California, if I give there to the insurance companies, they'll increase my fire insurance premiums and it is still I think a good thing to understand in terms of how to manage risk. Finally, to talk briefly about food security. This is a topic for this afternoon, it turns out satellite imagery, not surprisingly, it is good for predicting crop yield. On the commercial side of our business, we have a product we sell on Wallstreet that predicts U.S. corn and soy green yield and uses weather information and moisture adjusted index and if you look here between 2009 and 2012, 2012, it was a fairly bad corn year harvest in the U.S. It was bad rainfall. You see how much worse this was than in 2009, a great yield. That's good. U.S. is well-tracked. It is interesting for investors and it is well-tracked. The interesting thing about this, you can take the same issues and run it in Brazil and get the same idea of where the harvest is in Brazil which is now more poorly tracked, then you go to other places like Iraq, here we have been looking at predicting rice yield in Iraq. But since this has worked better, the higher resolution, the combination of the two. In Iraq we get this, actually you put the mouse on that and you click that video. This is part of the work we do on poverty and we have actually exuded yield by county there using this and further down this video, you start to see some very brown regions in the middle of the country and those corresponded if you go back on the Internet and look at this, you see the brown, they go back quickly. But those little brown patches corresponded to major famines and they were bad enough that people were going -- they were making appeals around the world for assistance during the famines. It sticks out clearly as soon as you compute, things like AI in a country-wide level using archives we have for the satellite imagery. In general, the philosophy that we take and I think it makes sense for the community, it is think across all scales. Here just to sort of drive that home on the left, we're looking at steel production using -- they have used a combination of non-vicki Hansonable spectral bands to detect the heat of the blast furnaces and we're able to be show that these little red dots that look like match heads, they're actually -- those are actually 2000° blast furnaces taking up a city block that runs for 6 months and produces tons ever steel, if you count up the red dots which we do automatically you get a nice correlation with the Chinese

steel production and you do that with the imagery and on the right we were looking at ship production and I like this example because it is actually digittable plus air bus and plus planet, some imagery is higher resolution than others and if you look at the whole video we get out of this, we can see the decks being laid, the basic deck, the ship being built deck by deck from the bottom-up and it eventually sales away, the general picture, using the technology, we can see in the big picture, you have the change, the poverty, food security, also everything we're doing economically, the shipbuilding, production, mining, all the way down to the people shopping at J.C. penny at the other end the supply chain visible end-to-end, that's where we get to overall mission here, it is common for all of us in the room. It is really to use these technologies, satellite technologies and nano technologies to really understand all socioeconomic change in everything that we're doing on and in the earth.

Thank you.

>> The majority of my job, it is to look at the relationship between natural resources, conflict, peace building. How natural resources are driving conflict, more importantly how they can support peace. In this context obviously we use a lot of global data, we use a lot of satellite data, we're looking now at the application of AI in some of these big questions. Today I'll actually raise it up a little notch and have a philosophical question. We'll talk about the major governance questions we should be discussing in the application of AI and planetary data. I have basically a personal confession to make. In my day job as we have talked about, we're looking to the SDGs, we look at the different environmental indicators and U.N. environment is responsible for 26 and I'm a global advocate for the indicators and for looking at how to best monitor these indicators. I have to admit, these indicators and the entire SDG framework itself, it causes my head to hurt. It is a real headache. I want to know if other people want to make the same confession right now. When you think about the SDGs framework, does it cause your head to hurt? Is it just me? Show of hands, anyone else? Causes my head to hurt and others to hurt. Why are they so painful? We have 17 goals, 169 targets, 244 indicator as and 193 countries. It is not just about single sector solution, not about achieving one goal but simultaneous achievement of all of the goals globally, putting it altogether and having simultaneous achievement for everything. Let's give an example. Who can solve one side of a rubix cube? Hands up? Straightforward, like a sector. Who can solve an entire one? A couple of people can handle that. Who can solve a cube with 11 sides, 193 sides, that's what it is to

solve the SDGs. I don't believe that the SDGs or planning for the SDGs could be solved with human capacity, I believe that it fundamentally will rely on AI as part of the planning process, part of the trade-off process. So ultimately I think actually Member States agreed on the framework precisely because they knew AI was coming and they knew AI would be what major solution here.

As we have heard about, the SDGs could be perfect for the application of AI if we have sufficient data and we have heard there is a testimonies of data actually on the horizon. A huge wave of big data coming, involving satellites, involving the whole series of different data inputs. This could be perfect for detecting global patterns, for looking at trends, for determining interactions between SDGs, for looking at predictions and for optimizing trade-offs between SDGs. We're in a really important time here in terms of how we use the technologies to take the SDGs forward. As we said, we have an unprecedented opportunity to access planetary data and I think the message that I have, it is about the convergence of the technologies on the horizon right now. It is not just about satellite data, it is about satellite data, mobile phones, Internet of Things, sensors, satellite citizen science, citizen data and also Open Source and the ability of Open Source data and software, it is the convergence of all of these.

Coulding together right now that we have to think about in terms of solving the SDGs. Getting in the philosophy and the governance questions that I wanted to raise. What keeps me up at night when I think of planetary data and Artificial Intelligence, I have five things that really chew threw my mind all the time. First and foremost, at the moment, the technologies companies, they have the capacity to use Artificial Intelligence with planetary data and this out strips everything that governments, any capacity that governments have, Civil Society has, et cetera, et cetera. You have a huge gap between corporate capacity to analyze the data and the ability of governments. The example from the U.S. right now, it is a fantastic one, you have the Department of Defense partnering with Google and Google earth engine to actually analyze the drone data and this is a controversy and the fact of the matter is, the State Department doesn't have the capacity to do this and they have to subcontract it out.

It is a huge issue. The question is, how do we close this capacity gap? How do we bring it -- reduce it, and how do we leverage it? How do government os, how do U.N. agencies actually leverage the potential that the companies have to do this big data processing and to use AI in the new world? Third question, how do we avoid information monopolies, the haves and

have notes of information and how do we avoid a State of pay to play where you can only access data to -- if you pay for it. How do we avoid the dependency, predatory pricing, the potential for predatory pricing, we're dependent on the the service and then the service is changed.

How do we encourage competition over services rather than competition over data. These are the questions that we should be asking. The great example again, I'm not picking on Google, I have a lot of colleagues goo, I admire them, they have done a lot to make satellite data accessible, but it is -- they're easy to pick on sometimes.

You may have heard just recently that Google map it is API is changing from a premium model to a pay to play model. This was a big shock to a lot of users. The question for us is how do we, how do we avoid this from happening or how do the companies need to be transparent if this is the intent all along?

A second big question, how do we use AI to reduce the information among natural resource stakeholders. This is a big cut-off here. What is at the bottom is access to information in a typical place where I work, where the company has the most information, the government has the information in the middle and the communities, they have very little information on the right.

So how do we actually reduce this wedge? How do we use AI and satellite data to actually bring this down. How do we avoid or the opposite, how do we avoid it actually going up and being exacerbated. A quick example. We won't say which country it is. The country that discovered oil, the actual value of the different oil blocks, the market value, it was about 1.8 billion, the company knew this, the government didn't really know what the actual value was. The question I have, it is what do you think the initial offer was for the blocks from the company to the government? Somebody just give a guess. How much do you think they offered to the blocks ? 200 million, 20 million was the original offer. The sad thing about this particular case, it is this particular government, because they weren't expecting to have oil, they didn't have the capacity to negotiate the contract, initially they sent a divorce lawyer tore negotiate the contract with the company. That's the kind of asymmetry in information and capacity that you have. My question is really how do we avoid this from happening or AI actually contributing further to this information asymmetry that you tend to have. Because companies will have a much bigger idea of the cost and benefits overtime of a project, they have a better information and environmental trends, natural hazards, market demands, et cetera, et cetera. How do we avoid that from

happening? The third, this has been talked a lot about already, what are the incentives in the standards that are needed to keep planetary data, satellite data, other kinds of data and the related AI algorithms in the public domain. This is an important one that we need to think about. This is one that Andrew normally that you cans about, how to make AI and the AI algorithms public and in some kind of a public registry. There are two issues here. We need to define what planetary data actually is, what is does it consist of, where is the boundary between the commercial side of that and the public good side of that.

You then need to figure out the global standards that will allow that plan theiriy ecosystem to function. What are the interoperable data form mats and open APIs, how do you classify the different variables, and natural resources, right now there is 6 classifications former ELs rests. How do you try to had bring that down to a single classification. How do you do monitoring, how do you do quality control, all of these issues, it is important to start to wrestle with when we start applying these kinds of questions and trying to make sure that this data remains or parts of the data remainses in the public domain.

The fourth question, who should manage and govern the planetary data ecosystem and the application of AI. At the moment, you know, governments don't really have a voice in the management of this ecosystem in the application of AI. Is there a need to have a public trust setup where this kind of information can go and some of these algorithms can go.

This has been raised as well, how do you start to build capacity to actually use this data by citizens, governments, et cetera.

Then the final one, this is I think a huge potential here, how do we start to use plan theiry data and AI to influence consumer choice and attract the impact of consumption. To give you a couple metrics that actually do blow my mind, if we look to see the amazon, how much amazon captures of online retail sales, you know, in 2017 it was about 50% of the entire retail holiday market, which is just huge. If you can begin tapping into that capacity to influence how consumers are making choices on this you can do amazing things. How can AI help consumers pick better product choices and make better choices. What can the U.N. do to enhance this use of AI in plan theiry data. You have heard throughout the conference, there is a series of agencies working on frontier technologies, applying different pilots on big data, on blockchain, AI, et cetera. That's already happening.

As Andrew said, that has to be consolidated and lead to a bigger strategy. There is a lot of ongoing action already

happening which is good. You have the global policy initiative, anyone here from global pulse? Fantastic, we have global fulse. Big data for Humanitarian Action, fantastic initiative that's trying to actually achieve what Andrew has said. It is consolidating. The U.N. environment assembly, our organization, we're having in March, 2019 or every other year, we're having the environmental assembly, all Member States coming together to look at different issues affecting the planet and the next one will be about technology innovation. A really big opportunity to actually start going through some of the governance questions.

From our side, I think this was raised a few different times. Ultimately we're starting to define what are the right questions we need to be asking that AI can actually answer. It is not -- you can't obviously apply AI to everything. It has to be selective. It fits the purpose. What are the big questions we should be asking that AI can help us answer. How do we maximize the amount of interoperable planet data in the public domain and how do we do that? The incentives, the policymakers, et cetera, to keep a portion of that data public.

Ultimately, we're trying to shorten the time between the collection of the data, the decision, the monitoring of the impact. Right now it takes almost a decade frankly, if you look at the multilateral agreement framework between assessment and large institutional response and investment and the impact monitoring, it takes too long. That's how you press that down into a more realtime process.

>> Finally, how do we enable all stakeholders to access planetary data and begin to use it. How do we move to the point of automated impact monitoring, as Andrew mentioned as well, how do we get the environmental monitoring much more automated and then brought into the decision-making processes.

That's the big philosophical questions that keep me up at night. Thank you for your attention and we'll have an interesting discussion.

Thank you.

>> Thank you, all. Fantastic talks it, I probably should have cut everybody off buff it was too interesting for me to do that. We have about 10 minutes I think for discussion. We have a number of questions already that have come up through the pigeon hole. I think I'll start with a couple of those and open it up.

So one question is it possible to monitor violence with earth observations and which elements?

>> Yes. I definitely say that you can monitor conflict situations with situational data. That's something we do on a daily basis. I would say that the wet and the challenges, how

do you potentially make that automatic Artificial Intelligence, so far that's proven difficult. It is so complex and often in very, very let's say challenging environment to analyze, even initially from my own experience, analysts point of view, being able to look at specific conflict situations, damaged infrastructure, different degrees of damage using Artificial Intelligence. Today I have not seen solid results on that yet. That doesn't mean it won't come. Again, that's also why potentially we could be offering training datasets from the analysis we have done at UNICEF and on that aspect. I do think it is possible to do. It could be secondary affects to look at for sure, refugee camps, et cetera, that you see, they're being developed as an indicator of conflict and which areas, et cetera, you need to focus on.

It still is a complex issue. I think it is important to also of course remember the whole political dimension around that. It is not necessarily helping a situation if information that's not properly quality control gets out there.

>> If I could just add, we have a very sophisticated humanitarian affairs programme where we work with a whole range of humanitarian actors directly. One of the things we're careful about doing, it is only releasing information that.

Coulds through the organizations and goes through the quality control process that's described. One of the organizations, it is Human Rights watch. I just will use it as an example. You would have used it my talk and for time I skip the humanitarian side. This is where recently there has been -- as many of you know -- significant ethnic cleansing happening. From January 8th to February 19th our friends were able to document the systematic raising of the villages. I think what's really interesting about it, first of all, it directly attacked the credibility of the stated reason for these bull dozings with buildings being on fire which were clearly not because we have the daily take every day prior to the activity it is important to know that this information, it was collected and analyzed in that period from the middle of January to the middle of February, the analysis was concluded on February 19th. It was released on February 21st. It was in the hands of organizations asking direct questions of government the next week. That speed of analysis and production of documentary evidence on that timeframe, that's the timeframe that's needed to change behavior. I'll just say it is an absolutely huge thing, we work with amnesty, Human Rights watch, a whole suite of organizations.

>> There is another I did mention that's I think worth -- first, it is clearly possible to monitor conflict situations, that's the military use of the data and we're just talking about

it being in the public domain rather than exclusively there for the spooks. What's more of a significant element here, it is the causes of conflict, gathering information that let's people avoid conflicts, peak measures, you take the development measures and one of the most serious factors is land degradation that's happening worldwide and actually based on detailed information on what's happening, persuading governments that they need to take measures, supporting the measures to say that they're having an affect. One thing that's been spoken about frequently, it is the drought that proceeded the crisis in Syria. These are factors, water, access to water, these are factors that actually destabilize fragile states.

Having that information upfront, it actually can possibly minimize the conflict situations.

I'll take one more question from pigeon hole which in several forms is about access to data. I guess one way of asking is could the rest of the panel react to David's point about the information asymmetry, the movement of information and analytic capability into private hands and so on.

>> Just to say, I mean, speaking as a space agency, providing all of that data, we see amazon, Google, other organizations and we're happy that the information, it is being used and that is the first thing to say.

The European Union, it is taking measures to set off its own capabilities and we have the data, the information, the access to make sure that there is a regime in which people can get it, and it actually takes care of all -- many if not all of the issues that you have had.

>> So I'll just add, it is interesting, if you look at the money that it actually costs to do -- to store the data, to do the AI, to aggregate the results, it is actually way less than the cost of flying the satellites.

Back in the day, when I worked at NASA, I was frustrated because I was always the AI guy, the software guy and every time we set up a new mission, you have seen it too, we set it up with a budget with budget for software, the hardware guy woulds overrun the budget and the software guys wouldn't get money. It happens again and again. That's actually part of -- I remember saying that when I started over there, no offense to my colleagues, but all of these hardware companies, they start up with money and use the money on the hardware and never have the money for the AI to interpret the data, we're just doing the data interpretation part. Getting back to the question, once the governments of the world and the funding agencies and the public sector, they realize the importance of what can be done with AI and with data interpretation, the money will flow. It doesn't take that crazy amount of money given what's spent by

the agencies on the hardware side. The information gap will fix over time. This is more of a function of the relative use of this technology and historical terms, we have been flying into space since 1960 give or take ain't the a ability of AI to do this kind of work is 3 to 4 years old. Once politics of the world catches up with that money, that will overflow and over time we'll address the gap.

>> This is a critical, super complicated problem. I don't know if you saw a couple -- at the ends I had a couple of bullet points on what -- some features of what I think our overall strategy has to be.

A critical element of that strategy, it is an open issue strategy. We need an open centric but not an open only strategy. We need to you shall for open data where we can, but we need to be prepared to work with non-open data where it is simply not available.

An important thing, we need an overall data acquisition strategy that's not about private sector organizations per se but across the board for all of the strategic forms of data that complement the critical investments that we're making in earth observation through efforts like this. .

The other thing, we have to focus heavily on looking beyond just open data itself and we have to look at opening algorithms and opening various forms of IP so those become common public goods and not captured by particular interests so that overall strategies can be used. We have to tackle the overall question of empowerment, access, and I don't think that means turning everybody in the community into a data scientist. I think what it means, engaging in product design, designing the kinds of information products and tools that can enable local communities. I would just give you an example. When we were turning, doing first light on the very first of const alation, a first image we had was over Brazil and we had a reference to see how the satellite image would compare to what was known about the local place. This is in the first 100 images or so and we looked a the this image, something is wrong with it. We said where is the neighborhood that's noted in the reference data and not here. There is a whole missing neighborhood in this image. Where did it go? It turns out that a bunch of land speculators bull dozed it ahead of the Olympics to try to put in something else and nobody had secure land tenure and they just came in one night with bulldozers and pushed everybody else.

We caught it. Completely by accident.

Imagine the ability to take those kinds of assets and create the information products so that people in the communities, they can use them from an advocacy, a legal perspective to demonstrate the actual affect that this has had.

We saw right interest the very beginning, that one accidental capture actually really shaped the thinking for years to come about the potential value and that's a user experience design question and we don't have those skills either of why they're displayed here.

>> Quickly, to add to that, we're talking about data for development. I think it is fair to think that in the near future in order to balance, to make it better for countries, it is not unforeseen that countries can take notes from the World Bank to develop this kind of infrastructure. It makes sense. If they don't have that capacity at the country level, and they're going to be left behind. It is very important that data is seen as road construction, infrastructure development and we need to develop the data infrastructure at the national level. Yes, you need to invest in it and use development and let's say banks to do so because unless countries actually get equipped, they're very much faced with the challenge.

>> Thank you all very much. We're actually out of time. The coffee, unfortunately, it is in the Popov room, you will need half of the time to get there and get back.

I see one persistent question over there, I'll give her a chance to ask the question. Go ahead.

>> AUDIENCE: Satellite imagery to track famine and drought and really I imagine some of the most well-endo youd users of the data are the Wallstreet speculators that take out positions on the futures and Option market and certainly from what you're saying I can't really see the LDC governments are anywhere near in the same position as Wallstreet brokers to be able to take advantage of these very new valuable data streams that you're taking. Do you think that the U.N. agencies may need to be a little more realistic if we're trying to help the LDCs.

>> That's the extension of the exact point I was also trying to make. This is going in many, many directions and that's one of them. How do different firms start to make speculation on differently natural resources when they have access to the emissions, it is not about being naive at all but how to govern and put in place a safeguard to mitigate the risks. It is a very realistic and very likely scenario, and that's exactly what I was trying to hint at not just in fragile states but in many Developing Countries. For example, I talked about negative things that Google is doing, we're partnering with Google and they have amazing infrastructure, they have -- I mean, Google earth engine, it is one of those transformative products that you only dreamed of 20 years ago and they're doing so much to actually facilitate access to the amazing data and NASA data and to put AI into that and allow us to look at global planetary haddie trends. We're looking at global water

monitoring, for example, with Google and with others and it is fantastic. It really is fantastic. The point I was trying to make, how do we avoid becoming dependent and having let's say costs for doing that in a manner that's not transparent and how do we ensure that there is universal access to that kind of capacity. Andrew calls it the final mile, how do we make sure that countries and citizens in less developed places have the capacity to actually leverage this, how do we go that final mile towards uptake and the behavioral change. That's the ultimate challenge we're facing.

>> Andrew has one more thing.

>> This is the last thing I promise. The well-known preelection of Americans to talk and talk. Thank you for indulging me on this last points.

A simple thing, the U.N. infrastructure, Member States, they need to come together, if you're going to start -- there are organizations on this stage who have raised more money to collect data and to pay for it than many U.N. agencies. You know, I just want to say, in addition to looking, advocating for open data, all of this stuff, this is not a commercial plea, I promise, the U.N. -- if the U.N. wanted to be awash in all of the planetary data it could imagine beyond that which is already made available by organizations like this, it could do so tomorrow and with amazing customer service. If it is simply became a customer. The U.N. agencies are the largest broke institutions in the world. They seem to be amazingly wonderful and we really, really want them and they then say but then could you -- they're like paupers, give us the table scraps of the data. Why are we in that situation? Why not go to a donor nation, we say we need to fund a global data infrastructure for the U.N. and we need to get, you know, a concession neural pricing and great licensing terms and great customer services and organizations in the private sector will provide all of that stuff, they would do it in a heartbeat, many want to do it well beyond the things they're willing to give away for free. We just haven't yet gotten over that hurdle where we say data enabled U.N. is something we're willing to pay for.

>> So the Irish can talk more than Americans. Ownership, the U.N., it is not a super power and companies need --

>> I'm cutting you off just because we need to give people a break! The next session, it will start at 11:00 #. Thank you very much.