**TARGET: Zero Hunger**
Episode 8

**Remote Sensing**

**[Sandra]** Hello and welcome to Target: Zero Hunger – a podcast that explores the food challenges and solutions of our time, brought to you by the UN's Food and Agriculture Organization. I'm your host, Sandra Ferrari.

**[NASA LANDSAT footage IN]**

**[operator1]** Status Check.
**[operator2]** Go Alice.
**[operator3]** Go Centaur.
**[operator4]** Go LDCM.
**[operator5]** T-minus 15 secs. T-minus 10,9, 8,7,6,5,4,3,2… [Engine blast]… 1, 0. And ignition. And lift off of the Atlas 5 Rocket on the Landsat Data Continuity Mission, continuing the 40 year legacy of preserving Earth's natural resources from space.

**[NASA LANDSAT footage OUT]**

**[Theme music IN]**

**[Sandra]** From oceans to land to outer space…

In this week's episode we will zoom out for a look at an increasingly important tool to measure the health of our natural resources – and that's remote sensing. Or earth monitoring from space.

We'll explore how the images we get from sensors on board satellites can translate into action on the ground.

And you will hear from one of today's biggest digital service providers - Google - which has become one of FAO's allies in the ever evolving fight to eradicate hunger.

You will also hear from FAO experts who will walk us through the ways FAO has been using geospatial technologies over the past decades. And how countries can harness big data to ensure we use our forests, agricultural fields and fisheries in a way that's both efficient and sustainable.

**[Theme music OUT]**

**[ERTS information video – U.S.A. Government IN]**

**[Sandra]** The recording that you heard at the start of the episode was from the launch of the latest Landsat satellite, which was sent into space by American Space agency NASA in February 2013.

Back in 1972, its predecessor, the Landsat Satellite 1, was the first satellite of its kind - sent into orbit for the express purpose of monitoring the changes happening on Earth.

**[NASA Narrator]** Seen from far out, the forests and fields reveal the spread of disease and insect

infestation. We can map the world from space and we can update the maps as the world changes. There is no end to the variety of ways space imagery may help us.

**[ERTS information video – U.S.A. Government OUT]**

**[Sandra]** At the time availability of that type of data was unprecedented. Information that once had to be gathered on the ground, could now be gleaned from a macro perspective.

Maybe you're wondering how that happened… how these organizations got access to this big data.

Well, in 2008, due to a change in data policy the United States Geological Survey – the USGS - decided that they would open up their entire archive and any new Landsat data to the public, free for use.

While Landsat was not the only satellite orbiting the earth for monitoring purposes, the U.S. has one of the most consistent records of data and it was one of the first countries to see the value of making these vast heaps of information available to the public for free.

So how exactly does FAO use this technology to support developing countries?

**[Erik Lindquist interview IN]**

**[Erik]** So google earth provides this global repository and people use Google search engine every day and that doesn't seem to be a big dead, but now we're actually using Google technology to help countries produce statistics, national level statistics that they then report as their national statistics to governing bodies around the world - the United Nations Framework on Climate Change, for instance.

**[Sandra]** That's Erik Lindquist. He's a remote sensing specialist with FAO's forestry department. He's going to walk us through how it all works.

**[Erik]** We'll talk about two different things today. One is Google Earth and the other is called Google Earth Engine, which is a completely different thing than Google Earth. Google Earth is a familiar map, like a 3D globe depiction of the Earth with high resolution imagery or photography that's updated frequently, which in and of itself is quite amazing.)

So if I just type in where my parents live – uh – where is that? I can just type in an address and search it will spin right into to where they live and I can see...

**[Sandra]** Is that their house?

**[Erik]** Yeah! That's their house.

**[Sandra]** That's a nice house.

**[Erik]** So that's where they live. And you can see how many trees they have planted in their yard, you can see the grasses and you can see how wide the road is….

**[Sandra]** Can you zoom in even more? How close can you zoom in?

**[Erik]** It depends on what kind of imagery they have available, but here you can see that they have a BBQ grill and some lawn chairs on the terrace. It's a sunny day so they've got the shades closed over the thing. I mean, you can almost count rocks in the garden, I guess. You can count roof tiles if you want. I don't want to take anything away! I make it sound sort of simple, but it was an amazing engineering achievement to do this. Incredible. But I think the bulk of users that have Google Earth, use it for things like this.

But what we can't do is get information in a systematic way from this picture. I can zoom into my house, I can see what's there, but how do I create information from that that I can analyze and make statements about on a large scale. What FAO has done has created, on the most simple level, we've created a tool that interacts with Google Earth – it's called Collect Earth – and it's basically a database that allows you to create data, that allows you to create data, create information from these images. And this is one of the things that we're working with Google on.

**[Sandra]** Can you walk me through a specific example? A project that you're working on in an area or country?

**[Erik]** Ya – of course – so here's an example in Angola. And Angola is one of the countries using Collect Earth to monitor forest area and forest area change in the country over time. As part of any national planning effort - how much forest coverage you have, how much coverage of certain types you have, and where those land covers are located and how those land covers are changing are sort of important for municipal zoning, regional zoning, reporting for climate change, mitigating climate change. All those sorts of things. With the FAO tool, Collect earth, we establish a sample, a survey basically, and at each point in the survey you can do what I just did with my parent's house, but you can actually use it to collect real information, store that and analyze it.

So this is one of the survey sites, we zoom right into it. I can click on the survey site and I get a data sheet. This is a very simple example where we're just estimating whether this plot here is forest or non-forest and whether it has changed over time from forest to non-forest or whether it has stayed the same. So – what is it? Has it changed? A very simple data sheet. These can get very complex – you could say how many trees are there? Are there roads in it? Are there houses in it? How many houses? How much road? Is there water? Is there agriculture activity? What kind of agriculture activity? Anyway, you can make it as simple or as complex as you want.

I think what Google does is allow people who know what to do it. Now what we can do is go straight to the analysis and spend most of our efforts analyzing things rather than preparing to analyze things. We can do now in a matter of days and weeks, what it used to take years to do. It's completely changed the way we look at the data source, the way we interact with the data source, what we can expect from the data we have at our hands. And people are doing incredible things. Things we couldn't have imagine possible even five years ago.

So just a basic example of how it benefits us, we'll go to Earth Engine, so earthengine.google.com, and we'll do one of these things called time-lapse which is this really cool thing. So, let's go to where you want to go - where do you want to go?

**[Sandra]** Somewhere really inaccessible.

**[Erik]** Ok, let's go the Congo – the Democratic Republic of Congo. Let's go to a place where I used to work

**[Sandra]** what's happening?

**[Erik]** The Earth Engine Zooms out and it's going to zoom in now to Goma. Goma is a city in the eastern Democratic Republic of Congo on Lake Kivu, which is on the border between Democratic Republic of Congo and Rwanda. And it's going to show you a time series of the Earth's surface from 1984 to 2012. This is all Landsat data. It's taking all of the data we have for the entire world for every year and creating an image composite, and shows us what's going on. And in Goma you can see the expansion of Goma – as it gets bigger and bigger and bigger

Again - we're looking at a picture here - but the data behind it allows us to produce information, generates statistics and make reports about how much of the land is changing and what it's changing to and changing from. Now the hope is, the idea is that we're able to produce information, almost in real time, to say, "This is what's happening," and to provide our decision makers with the kind of data that they need to make decisions. Is this what we want? Do you we want this to happen? What are the tradeoffs? There's economies at stake. Are there livelihoods at stake Are there other things at stake, other than what you just see here? And before that was very difficult to achieve. Special credit to the satellite providers, the space agencies that are launching these satellites, that are putting these instruments in space and making their data available.

**[Erik]** Look! Here's an example. I kind want to show you this. So Adolfo Kengard is an FAO colleague in Latin America, doing remote sensing for Forestry. He sends me an email this morning saying, "Look at the results from the first script of the biomass map of Honduras. So this is based on field data and Google Earth engine, so all of the things we just talked about. He sends me a link to the script, I click on the link, up pops the project that they have done for mapping biomass and change in biomass levels over time.

So, one of the cool things too, that Earth Engine allows us to do… Right now I'm sharing computer code with different countries. And I can't write computer code, make it available immediately to my country counterparts the technicians I work with in – in this case it's Equador – we have Zambia, Democratic Republic of Congo. I can make what I wrote available to them immediately. They can edit it. Make it available back to me. And we can trouble shoot. Make things better. We can customize the results for each country.

**[Sandra]** According to Erik is that the idea behind satellite imagery is not that it replaces field collected information but that it's there to augment it.

Field collected information is the most expensive. It's the most time consuming kind of information to collect. So what they do is produce this information, from the Satellite data. Forestry colleagues in the national ministries then go to the field, with the map product for instance, and start to validate whether that map product is…. correct.

**[SFX walk through a forest IN]**

**[sfx of footsteps in forest]**

**[Sandra]** So - Adolfo was in the Dominican Republic doing a training on land cover classification as part of a joint meeting with the US Forest Service SilvaCarbon program.

And they were checking land cover classes in the field and how to classify land cover based on what is visible on the ground versus what is visible in the satellite image. This validation process is also known as “ground truthing”.

Ground-truthing - or the act of map validation - is important because all maps have errors and we need to be able to quantify how certain they are about what our maps are saying.

**[Rustling map papers]**

**[Sandra]** The map says Adolfo is in the forest… is he standing in a forest? If he keeps walking further… **[sfx of footsteps in forest] [Tropical birds]** He and his team are supposed to see some agricultural activity at the boarder of this forest. I s that correct?

**[sfx of footsteps in forest OUT]**

**[Sandra]** Accuracy is relative and depends on the purpose for which one would like to use the map. Sometimes high accuracy is important. Sometimes it isn't. Either way, it is up to the user to decide what kind of accuracy is suitable for the use of the map.

But in what way does geospatial technology have relevance for farmers in remote or rural areas?

**[Sandra]** I spoke with one of FAO’s main remote sensing experts.

**[John]** My name is John Latham. I am a senior environmental officer in the office of the Deputy Director General for natural resources and I am head of geospatial management inside the organization.

It’s critical to famers. They need to know what and where to produce. To monitor closely the crop life cycle during the growing period. How well it’s growing. Whether it’s under stress. What is the availability of natural resources to support the life cycle? What is the optimum planting date? What else is being grown where? We use geospatial technologies to monitor the transfer of the final product to market. How far do we have to transport that product? What else is being produced? At what price and what area? Are farmers producing the optimum crop in the optimum area? The areas which are most sustainable? We can also look at it in terms of the determination and location of farm inputs – where is irrigation water available? Where is machinery located? What fertilizer and seeds are available?

And that’s particularly important if I could take the recent example of the floods a few years ago in Pakistan. Having mapped the country. Having detailed information of what is produced where. We then had the onset of a major series of floods on an annual basis. By intersecting the information of what is produced where, with flood information, we were able to then provide timely advice of which crop, and indeed, which seed should be moved to which area so that they can optimally

respond in times of crisis. I think that was a very good example of operational use of remote sensing, as well as other ancillary data.

Taking it further in terms of what else we can do of course, we can monitor whether in real time. You see that every day on the news. So we utilize weather conditions to improve early warning and forecasting, including the weather impacts on crops. Through agricultural stress indexing we're able to look at whether is aridity occurring in the world, and weather crops are likely to come under stress, which would affect the overall productivity thy yield. So we also utilize remote sensing to look at the state of the environment, a whole variety of parameters pertaining to the environment. We use it to reduce risk to mitigate – the severity and the impact of natural disasters. And indeed start to use it to advise farmers of how to adapt.

So the expansion also – of internet connectivity and smart phones gives us opportunities to develop mobile, web based applications. To reach – in real time – small farmers, with vital information and actual knowledge, so that we can put a combination of information, either in text, graphic, art, sound animation or video form and put that into the hands of famers to empower them to make the right decisions at the right times.

**[Sandra]** John has worked in remote sensing since the early years of the technology, starting his career at FAO in 1978 as a field officer. According to him, while the technology was, of course, revolutionary at the time, it wasn't without challenges.

**[John]** We go back a long way when it comes to the utilization or remote sensing. And that started when we were using paper maps in analytical form. That was much more different than today's information which is digital. We used aerial photography, and we used photogrammetric measurements to analyze and to extract information. Most of that was manually based. It was extremely difficult and tedious and long winded to be able to extract the information. Very costly. And probably unsustainable for the organization.

**[Sandra]** So when you were using paper maps, they would just get mailed to you from one source to another… and you would unfold them… and then how would you do your work?

**[John]** Well, let's look at it in two different ways. We have a variety of information that existed at the country level and we would collect that and use it as part of our analysis. The visual and analogue interpretation of that information. If the information didn't exist and satellites were not operational and that time, than we could commission the acquisition of remote sensing information through aerial photography. And then we have to analyze each of those small aerial photographs and extract the associated information. So a very slow, tedious but very important process.

**[Sandra]** And what are the challenges associated with these traditional methods of data collection?

**[John]** The challenge certainly was one, that it took time to commission and to complete the analysis of the status of any of the natural resource base of a country. We had high costs of data collection. We took time to process the data. So, there's an issue of cost, timeliness, reliability, accessibility. And then – unlike now - we had difficulties integrating it with other information because it was not digital. So we also had the problem that with aerial photography it takes a very narrow field of view of an area. With satellite imagery, we get large area coverage and multiple wave lengths of the electromagnetic spectrum. And more frequently. Much more frequently. So we had a whole issue set

dealing with the cost of the data, the problems of transposing information from an analog or digital domain, the unreliability of much of the datasets we were receiving.

**[Sandra]** What do you mean by "unreliability".

**[John]** (Well, if you monitor on a single date the probability is that you won't necessarily have it associated with the optimum date for monitoring, in terms of what is happening. Now we can do the same survey and repeat that every five to ten days, from satellites. It's made a dramatic change. That improves the reliability and the quality of the data that we collect and the analytics that we perform on that information.

**[Sandra]** As John mentions the acquisition of this type of geospatial data was very costly at the time and presented a lot of challenges for experts working with the data.

In recent years, however, we have seen, what he refers to as, a dramatic paradigm shift.

A shift to digital technologies and the internet that allows organizations to acquire big data in a much more cost effective and sustainable way.

And this data has opened up big opportunities for one company that has become synonymous with the technology – Google.

Rebecca Moore, Google's Director of Google Earth, Earth Engine & Earth Outreach recently came to FAO with her colleagues to and elaborate a bit more on their work with remote sensing technologies and the eventual partnership forged between Google and FAO.

**[Google-FAO_Event-Moore IN]**

**[Rebecca]** Good morning everyone. It's a great pleasure and honor to be here. Thank you very much to the Director General and the Assistant Director General Rene Castro for welcoming Google here to share our experiences with you. I think people are curious about how FAO and Google - which seem like such different institutions – managed to create partnership. I even saw a rumor I also saw a rumor that FAO and Google were planning to merge! So Director General, we need to decide, are we going to call it Foogle or GAO? **[Laughter]**

The key point here is, it's these partnerships that bring our technology to life and to use. We at Google are very proud of our ability to manage big data, do this type of computation, create easy to use types of tools like Google Earth, but we are not the experts in sustainable forest management, in mitigating hunger, in governance, in the advanced science of these types of driving information, and so that's why these partnerships are critical. And so that's why we are very excited to have kicked off this partnership in December with UNFAO.

It is a very challenging time in the history of our planet. No one type of institution is going to solve the problems we face with climate change with sustainable development. And yet what I think is exciting to see with the partnership of FAO and Google, we can bring our unique strengths together and create this common vision and really make a difference for the future of the planet and our future generations.

**[Theme music IN]**

**[Sandra]** Satellites have opened up opportunities for data collection as wide as space itself. And increasingly, that data is literally at people's fingertips, on their computers at home and smartphones in their back pocket.

But it's what we do with that data and who we involve in analyzing and giving meaning to it that will ultimately decide its true value to us -- the global community.

The more we build partnerships around big data – bringing farmers and experts from all kinds of fields together to combine satellite and ground data in new ways – the more we will learn new things about the health of our forests, agricultural fields and fisheries, so we can build better strategies to use and protect them in the future.

This episode has been produced by myself and Kim Jenna Jurriaans.

If you have any questions or feedback for us please write to FAO-audio@fao.org. I am Sandra Ferrari. Thanks for listening.

**[Theme music OUT]**

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