The business view: business services to support disaster risk

Interviewers: Gareth Byatt – Principal Consultant, Risk Insight Consulting
Ana Prados – Senior Scientist & Researcher, University of Maryland, Baltimore County (UMBC)
Interviewees: Shubharoop Ghosh – Vice President, ImageCat
Marina Tamara Mendoza – Engineer, ImageCat

October 2023

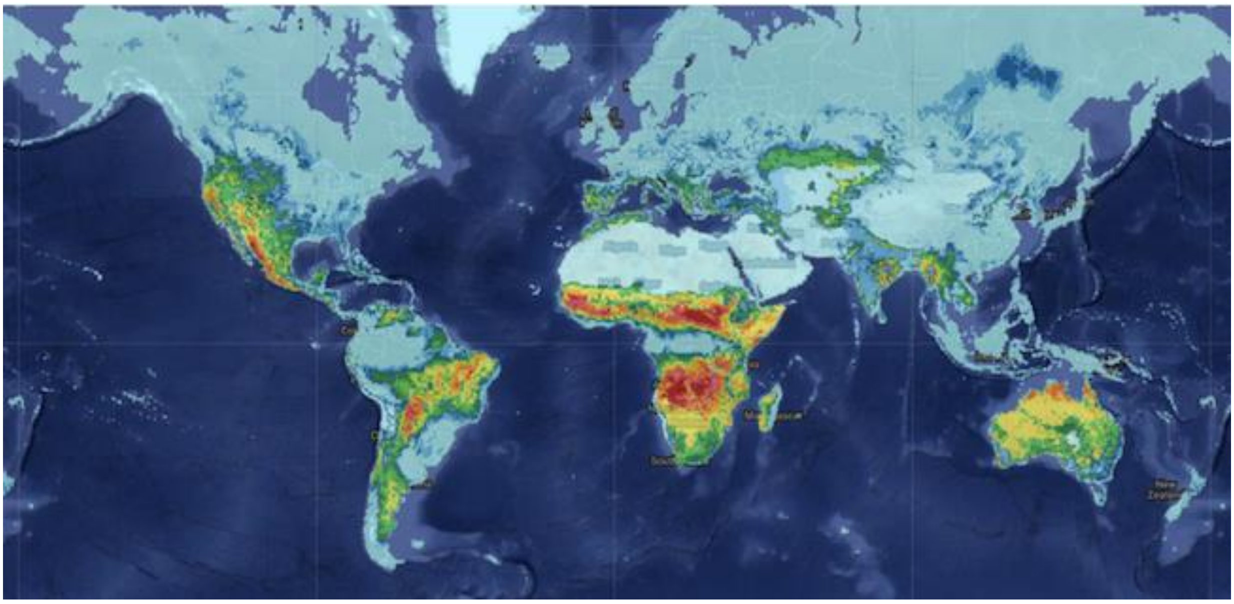

Figure 1. Global Wildfire Risk Index Map developed by ImageCat

Shubharoop and Marina,

Thank you for making the time to talk with us about the work of ImageCat, including your initiatives and involvement to support NASA Earth Applied Sciences.
Perhaps we could start with an overview about the ImageCat business and your professional backgrounds?

Shubharoop: *Hi Gareth and Ana, it is a pleasure to be speaking with you and thank you for the opportunity to discuss our work.*

ImageCat is an international risk management company specializing in the development and use of advanced technologies for risk assessment and reduction.

Since 2000, we have developed a reputation for innovative solutions in disaster risk management, quantification of the built environment, post-disaster damage assessment and software development.

As the Vice President of ImageCat's data services, my role involves developing and managing a diverse portfolio of data products and platforms, including global exposure databases, an extensive library of remote sensing and field-based disaster damage data, and web applications for government, insurance, and nonprofit clients.

I have always been fascinated by the design of cities and communities, how people live in them, interact with their surroundings, how they travel to places and how communities' function with water, power, and technology. Over the last twenty years, my work has focused on understanding how natural disasters impact communities and affect lives, properties, and livelihoods. I have a master's degree in urban planning from the University of Southern California's Price School of Public Policy in Los Angeles and an undergraduate degree in Architecture from Jadavpur University in Kolkata, India.

Marina: *Ana and Gareth, thank you for inviting us to this discussion. I'm Dr Marina T. Mendoza, Engineer at ImageCat. I work in disaster risk management and climate change adaptation with government agencies, international institutions, and commercial clients. An important part of my job also includes R&D in the same areas. I have over ten years of experience in disaster risk management for multiple hazards (floods, earthquakes, wildfires, climate hazards, Natech). I started working as a civil engineer in flood management in Argentina, mostly focused on structural measures, and I saw the need to take a more holistic approach to manage risks also through non-structural measures such as land-use planning and risk transfer. That is how I decided to continue with my studies to learn more about other hazards and how to prevent risks in the first place.*

I hold a PhD in Urban Planning, Design, and Policy and a master's in civil engineering for Risk Mitigation from the Politecnico di Milano in Italy and I also graduated with honors in Civil Engineering at the University of Buenos Aires, Argentina.

Gareth: Thank you for this overview, Shubharoop and Marina. It's great to understand how ImageCat has evolved, and to know about your backgrounds.

I know that ImageCat provides a range of data services to help clients assess and understand how disaster risks can affect their organisations / geographies. What are some of the particular focus areas for you at the moment? I know that R&D is part of your activities, and that as part of this focus you are doing some work to see if a machine learning model can detect fire patterns and perhaps smoke as well to assist fire services teams.

Shubharoop: *As you have noted R&D has always been at the core of ImageCat's activities. We have an established record of high-quality research in the area of disaster risk reduction.*

We have been successful in securing research grants from over a dozen US government agencies including National Science Foundation (NSF), National Aeronautics and Space Administration (NASA), United Sates Geological Survey (USGS), and the Federal Emergency Management Agency (FEMA). We have also received several international research grants from institutions such as the United Kingdom Space Agency (UKSA), European Commission Framework Programme 7 (FP7) and the UK's Environmental and Physical Sciences Research Council (EPSRC).

Our work is organized into four major areas:
1) disaster risk management including forecasting, response, and mitigation;
2) exposure development and catastrophe modeling;
3) software platforms and data, and
4) research and partnerships.

Our recent research funded by the NASA Earth Science Disaster Program focuses on critical infrastructure exposure modeling and development of a Global Economic Disruption Index (GEDI). This suite of research work utilizes a Machine Learning (ML) model for developing exposure datasets. In the context of the critical infrastructure work for NASA, we use supervised learning to train the ML model on various Earth Observations datasets. Once trained, the ML model is used to generate global areas of critical infrastructure and industrial activity. Another example of applying AI/ML is the sectoral disaggregation of economic activities for our GEDI product. To add sectoral resolution to Earth Observation derived exposure data for the GEDI, we use AI to predict which geographic regions contain which industrial sectors of the economy, so that the economic data can be distributed out more accurately.

Marina: *We have several ongoing projects under the NASA Applied Sciences Wildland Fire Program. I am a co-investigator for the "FireCapture" project that utilizes earth observation data and machine learning technologies for wildfire detection. This NASA-funded project is led by ImageCat in collaboration with partners Intuition Machines and HSR.health. We introduced for the first time the use of the well-known online captcha system called "Human Platform" to crowdsource a very large number of labels on satellite wildfire imagery, to identify active fires, burned areas, and smoke. Labels are then used to train ML models for wildfire detection for reliable, real-time delivery of intelligent analytics for the wildfire end-user community, first responders and medical emergency teams. This is a very innovative project where we successfully tested the captcha technology, which is generally used for online safety, in a completely new domain of wildfire satellite imagery that we hope to develop further. We hope that this work can help to avoid wildfire disasters.*

Gareth: The work you are undertaking sounds very interesting – we appreciate this overview. I was interested to find out about one of your projects that is funded by NASA Earth Applied Sciences, in which you are working on a Community Wildfire Vulnerability Index for Risk Assessment and Response Planning, using Earth observations data and modelling. Could you outline the core aims of the project?

Are there any linkages between this index and the UNDRR (United Nations Disaster Risk Reduction) Arise wildfire disaster resilience scorecard?

Shubharoop: *Thanks for mentioning this project. With funding from the NASA Earth Science Applied Sciences program, ImageCat is working with researchers from the University of California, Irvine on this innovative project titled "Community Wildfire Vulnerability Index for Risk Assessment and Response Planning using Earth Observation Data and Modeling". The project aims to estimate vulnerability and loss potential at the community level to support effective risk management decisions within local, state, and federal government agencies in the US, as well as private sector organizations such as insurance companies. The development of the Community Wildfire Vulnerability Index uses data derived from Earth observations, wildfire hazard maps that define Wildland Urban Interface (WUI), building-level response functions for wildfire damage and loss, community wildfire planning / design tools, and social vulnerability indicators.*

Marina: *There are some commonalities between our Community Wildfire Vulnerability Index and the UNDRR Arise wildfire disaster resilience scorecard. For example, the essential element "Resilient development and design" from the scorecard has many aspects of community design that are crucial for wildfire management that we are also considering such as zoning, construction in the WUI, building codes, and other standards. We are also considering the disaster response capabilities of communities, as in the disaster response element in the scorecard. One of the main differences I see with the UNDRR scorecard is that we use different data sources to determine the indicators for the index at the community level (EO, GIS data, census data, etc.) in a comparable way and we will work with 2 pilot communities to expand on these, whereas all the scorecard elements are evaluated by the community itself and probably meant to be used mainly by that community.*

Gareth: The Wildfire Urban Interface (WUI) that you mention is very interesting to us – it is an area that we are reviewing in our NASA funded research work on disasters avoided. We appreciate understanding the linkages with the UNDRR Arise scorecard, too.

I imagine that you use satellite Earth observations data from a variety of sources in your work. Is it relatively straightforward to obtain and use data from public sources, including NASA, and do you sometimes combine publicly available data with privately owned data to create specific data needs for clients?

Shubharoop: *Yes, satellite-based Earth observations data is a key input for the majority of our work. We collect Earth observations data from a variety of sources depending on our specific needs for developing products and supporting our clients. We use satellite data from public and commercial sources for building and infrastructure exposure development, disaster monitoring, emergency response including situational awareness, damage assessment and for tracking recovery and planning.*

Public sources like NASA and the USGS EROS Center provide free online access to search, display and download satellite data. We also use commercial sources of high-resolution data from providers such as Maxar, Planet, and several other companies. Typically, Earth observation data is used in conjunction with other Geographic Information System (GIS) data for assessing damage or for developing exposure databases.

Depending on the scope of a project, our analysis usually begins by compiling a catalogue of Earth observation data that is available or working with satellite imagery companies to acquire new data for an area of analysis. To give you an example, during the response to the 2010 Haiti earthquake we collaborated with several satellite and aerial data companies to acquire high-resolution imagery for a Post-Disaster Needs Assessment (PDNA) for the World Bank / the Global Facility for Disaster Reduction and Recovery (GFDRR). The imagery was used to perform detailed building damage assessments of the capital city of Port-au-Prince and its surrounding areas. It was during the Haiti earthquake event that damage interpretation was crowdsourced for the first time. We engaged with over 600 expert scientists and engineers from 23 countries in this first-of-a-kind initiative; this effort was highlighted at the 2010 World Bank Understanding Risk conference and in numerous publications as well.

The distributed nature of crowdsourcing was also used for post-hurricane damage interpretation using satellite and aerial images for FEMA after the 2012 Hurricane Sandy. The outputs of these expert-generated interpretations were openly distributed as web mapping services (WMS) into a number of online GIS platforms.

Ana: We appreciate the outline of your use of Earth observations, Shubharoop. How is the satellite data incorporated into the Community Wildfire Vulnerability Index for Risk Assessment? What is the relative importance of the satellite data compared to the other data that are used to derive the index, in other words how big of a role do they play in deriving the indices?

Shubharoop: *Satellite data plays a crucial role in the development of the Community Vulnerability Index, enabling communities to assess the potential impact of wildfires on both physical and social assets. In developing this index, a combination of hazard, building exposure, and social indicators is utilized. These indicators primarily rely on satellite data in conjunction with other Geographic Information System (GIS) and demographic data.*

Newly generated Wildland-Urban Interface (WUI) maps from our research partner UCI represent regional hazard conditions and these form an integral part of the community vulnerability index. These WUI maps are predominantly derived from satellite data, including fuel vegetation data such as LANDFIRE and building footprints.

A key physical indicator built into the index, that of building-level vulnerability, is established using satellite data which characterize fire hazard intensity.

Real-time fire and thermal anomaly sensor data from a number of sources is used – specifically NASA's MODIS (Aqua and Terra) and NOAA-20, and Suomi National Polar-orbiting Partnership (NPP) VIIRS I-Band sensor data – to define wildfire perimeters and fire intensity. Fire intensity values are extracted from the assessment of the Fire Radiative Power (FRP) parameter. In areas affected by recent wildfires, data from the CalFire DINS building damage database is used to extract FRP values at damaged building locations to determine the severity of fire exposure for each structure.

The outcome of this analysis yields a set of "building response / vulnerability functions," which consider the severity of the fire hazard and the contribution of various building characteristics to overall losses in the event of a wildfire. The Community Wildfire Vulnerability Index includes indicators related to social vulnerability, primarily from the American Community Survey (ACS) derived from the United States census data.

Gareth: Thanks for sharing this additional detail about your use of satellite data, Shubharoop. In our Disasters Avoided initiative we have also seen some examples of UAVs and drone use, and how their use could evolve in future, for avoiding disaster events and responding effectively to events that occur. For example, in Australia we have looked at examples of drone use to help prevent wildfires (bushfires), including flying over bushland to monitor and spot trees set alight from lightning strikes (of which there are many in Australia). Do you use data from UAVs including drones and airplanes also, as well as satellite data in your work?

Shubharoop: *UAVs are becoming increasingly popular and effective in data collection for various purposes related to building / infrastructure inventory management and health monitoring due to their ability to access hard-to-reach areas and capture high resolution data and images most efficiently. The data collected by UAV's can be used to extract building information on façade, roof, and other attributes, used for detecting structural conditions.*

UAVs provide efficient ways of collecting building condition information and extent of damage after major disasters such as hurricanes, floods, fires, and earthquakes. This information is critical for rapid response, search, and rescue operations. Recently, UAVs have been used to survey damage to buildings after the 2014 Napa earthquake. Video data collected using drones in the immediate aftermath of the Napa event provided timely situational information for response and recovery. We have used this information in some of our research and post event activities.

Our wildfire research collaborators at UC Irvine use UAV equipped with LiDAR, thermal and multispectral cameras along with regular cameras to obtain detailed map of forest structure before and after prescribed fire, as well as observing fire front progression during controlled burn operations.

High-resolution aerial photos and videos collected from airplanes can be used to provide situational awareness and assessments during pre or post disaster conditions.

In the aftermath of the 2005 Hurricane Katrina, aerial photos collected by ImageCat, NOAA, and US Army Corps of Engineers (USACE) offered the first available, highest-resolution images of the heavily damaged areas. After the devastating 2014 Balkan floods, ImageCat led a World Bank funded aerial mission to collect imagery over Serbia to support post-event damage assessment. Georeferenced aerial images collected by a local imaging company over the flooded areas were used to develop flood boundary for the event. The flood extent was then used with ground surveys of flood high-water marks damage to establish depth of flooding at flooded building location and estimate building losses.

Gareth: We appreciate your outline and examples of how UAVs are being used. Your description of capturing data leads me onto some of your products. I know that you track global catastrophic events, and that your data is being used across various industries – for example, one of your products, Inhance© supports insurance companies with area screening and underwriting, and for their scoring metrics to factor in hazards and risks across the globe. Is the cost and ease of obtaining detailed data becoming more accessible to businesses to make good use of for their strategic and operational planning? Are you involved in the Geospatial Insurance Consortium, out of interest?

Shubharoop: *Yes, it is a correct assumption that reduced cost and ease of access is fuelling the greater use of detailed catastrophic data for insurance companies and corporates in their strategic decision making and operations. However, I would like to comment on the landscape of hazard and risk data.*

The use of hazard and risk data that has been standardized to represent industry accepted metrics like hazard severity scores, risk accumulation scores, average annualized loss, loss ratios have proliferated.

The uptick in usage of such datasets have been due to advances in technology. For example, cloud computing, big data analytics, APIs, large sale data visualizations have made it easier for insurance and other businesses to adopt the use of high-resolution catastrophic data from multiple sources.

Furthermore, there has been an explosion of data providers in the risk space from catastrophe modelers, multi hazard data providers to insuretech companies focusing on data creation that has created competition driving prices lower.

Although we are not involved with the Geospatial Insurance Consortium, we are quite familiar with the partnership model. The aerial imaging and data platform technology underlying the GIC (i.e. Vexcel and ESRI) are leading edge in the industry and it is a promising technology tool for insurance companies to have at their disposal.

Gareth: Is your data on risks and exposures in different geographic areas being used by local authorities and businesses to jointly work through their resilience and collective business continuity options? When I interviewed Peter Williams, the Chair of Arise-US in September 2023 we talked about the importance of city and local authorities working in a properly integrated way with businesses in their localities. For example, a business operating in a particular location can have a detailed and comprehensive business continuity plan to deal with disruption affecting its specific business, but if its people, suppliers or customers can't get to its location(s) because public infrastructure is out of action / damaged, they will suffer disruption consequences all the same.

Marina: *We have been providing site-specific or building level hazard and risk information to insurers, real estate investors, and corporates for a long time to help them make different underwriting, pricing, claims and other risk management decisions. ImageCat also has a long history analysing and studying disaster impacts to lifelines.*

Lately, we have started looking at the problem from a regional perspective, to be able to incorporate the effects of economic disruption and cascading impacts from damages to critical infrastructure and manufacturing that you are mentioning. There is no point on having a building resist a hurricane or a wildfire if the rest of the area is devastated, the economy is ruined, and people are gone.

With the support of NASA's Disasters Program, we developed the Global Economic Disruption Index (GEDI), which we mentioned earlier, as a method of describing the economic recovery following disasters, and a parallel development that uses Earth Observation (EO), catastrophe risk models, and economic models to predict GEDI values for specific events. The GEDI scale ranges from I to V, from slight to catastrophic, with an associated expected economic recovery in the order of hours, days, weeks, months, or years. In addition, starting from the impacts to critical infrastructure and the manufacturing base that can be detected from Earth observations data, we are able to trace cascading impacts through other economic sectors and countries.

By talking with different potential end-users, such as NGOs, corporates, insurance brokers, financial institutions, commercial real estate investors, and also various levels of governments, we have jointly identified different uses of GEDI including integration with advisories for impending or recent events, identification of potential future events for prioritizing mitigation, Environment, Social and Governance (ESG) reporting and forecasting the impact of climate-based disasters on specific sectors, diversification of real estate investing, parametric triggered insurance, and identification of risks for the purposes of equity.

Gareth: Thanks for these examples of your linkages with local authorities and also the private sector, Marina.

By way of a related question focusing on specific geographic areas, do you carry out any work to support small islands, for example the Small Island Developing States (SIDS) network? SIDS are one of the geographic groups that we are looking at as part of our Disasters Avoided initiative.

Given the coarseness of the public satellite data, does this present a problem when conducting satellite-based studies in Island states? In this case, do you rely more heavily on commercial data?

Marina: *Yes, indeed we do. We have recently supported the Department of Environment, Government of Antigua and Barbuda in the "Climate Change Risk Modelling Project" as part of the National Adaptation Plan process and a subsequent Sectoral Adaptation Plan development for the Wholesale and Retail sector. In projects on climate change and disaster risk modelling we use multiple data sources. We mostly use satellite imagery to develop building and critical infrastructure exposure databases to assess risks. In some cases, higher resolution aerial photos are available from government agencies, however this is not always the case. Even though satellite imagery is a key element in our exposure development process, we use numerous other sources to complement the data such as existing GIS layers, digital elevation models, climate data, census data, structural information, building codes, etc. Commercial sources for higher resolution satellite data are always an option, but not a requirement or a limitation in these types of projects. If a risk assessment project has data budget available as a part of the package, this can be used to source commercial data. This requires advance budget planning from the government agencies undertaking such projects.*

Gareth: Given everything we have discussed so far, I'd like to talk about how data can be used to support scenario analysis and counterfactual thinking.

For context, through our Disasters Avoided initiative case studies (of examples of good work being undertaken around the world to avoid disasters) we are seeing a number of themes, two of which are (1) the need for a mindset change to rethink how to avoid disasters, and (2) having good data. We are seeing examples of people being open to different and new ways of approaching problems.

As one example of this, when we have a good data set about disasters that have occurred, we are interested to see the scope to apply counterfactual thinking, to use this data to look at how a particular disaster that has occurred could have unfurled differently, with either more or less impacts, to see if this way of thinking can help us be more prepared for future disaster risks. I'd be interested in your thoughts on using data models for this type of analysis.

Shubharoop: *We employ stochastic models based on counterfactual thinking to address a diverse range of challenges in disaster risk management from seismicity and climate change to exposure development and network analysis. Counterfactual thinking is key for justifying the use of catastrophe risk modeling tools and advanced technologies – so it is indeed an important way of thinking for us.*

To illustrate, consider the scenarios in which Search and Rescue teams, during certain catastrophic events, were unaware of severe damage in specific regions, resulting in a higher loss of life. What if they had possessed this knowledge? This underscores the imperative need for rapid post-event modeling and damage detection through remote sensing technology, ensuring efficient resource allocation.

Following the devastating 2015 Nepal Gorkha earthquake, we harnessed satellite data and sophisticated modeling techniques to pinpoint the most severely affected schools and hospitals across the rugged mountainous districts of Nepal. These damage assessments were shared with the UNICEF program manager in Nepal, enabling the prioritization of aid distribution to the districts most severely impacted. The application of such technical tools was instrumental in delivering vital assistance to the most vulnerable populations located in the remotest corners of Nepal.

We focus on using empirical data from historic events to provide insights into evolving risk profiles, empowering individuals, and organizations to make informed decisions. One noteworthy example from a NASA's Disasters Program project involves the application of GEDI to provide a Regional Risk Assessment for commercial real estate investors. By drawing from past events that have influenced the regional economy, we identify areas where climate change is likely to trigger economic disruptions in the future.

Gareth: This is very interesting, Shubharoop. It's great to see the application of counterfactual thinking in this way.

Two linked questions for you both to finish with, if I may. How do you see disaster risk data management evolving over time, and what is the most important focus to deliver up to 2030 (perhaps linking with [the Sendai Framework for Disaster Risk Reduction 2015-2030])?

Shubharoop: *The challenges associated with disaster risk data management is not static, it is evolving and dynamic. We have made major strides to address different aspects, but we have not yet been able to solve it all as a community of practice.*

We have all agreed that we need accessible and timely data on hazards, exposure, vulnerability, risks, post disaster impacts, local-level data (to complement global and national), disaggregated data by gender, age, disability, income etc., and that we need to take action to achieve this. What this action constitutes is still unclear.

Data are being collected by multiple actors for different purposes and at the moment we are working in silos (which is not a criticism, it's just how things have evolved to present). This includes government agencies at multiple levels, the private sector, researchers, international institutions, humanitarian, and development organizations, etc. This also translates to the technology and systems that are being used, the way data are stored, the data architectures, the formats used. This can limit the types of analyses that can be performed and the data that can be shared.

Also, the data that is being collected for a specific purpose is often unsuitable for use in other purposes. For example, the Sendai Framework indicators require countries to collect data on disaster losses to track progress in implementing the seven targets of the framework. Data on losses are generally already being tracked by different agencies within countries for accounting purposes, to reimburse the population, to ask for government or international funds, for assistance, and often collected at the household level. However, when researchers want to use the data for other purposes, e.g., to better understand vulnerability of buildings or the population, they realize that important data was omitted from this data collection effort (e.g., building characteristics, mitigation measures, hazard data, etc). Furthermore, security and privacy concerns further complicate data sharing.

***Marina**: There are many efforts that have been made towards solving some of these issues, particularly from an ICT perspective, from governments, international institutions, and researchers. An example from the government side is the multi-agency effort to develop the GeoRiskPH platform led by the Philippine Institute of Volcanology and Seismology (PHIVOLCS), funded by the Department of Science and Technology (DOST) with the vision "to be the Philippines central source of information for accurate and efficient hazards and risk assessment to help the government increase the nation's resilience to natural hazards". Internationally, the Global Facility for Disaster Reduction and Recovery (GFDRR) has just released the Risk Data Library Standard (RDLS), "an open data standard to make it easier to publish, access, share, and use quality disaster and climate risk data". From a research perspective, the European project IDEA (Improving Damage assessments to Enhance cost-benefit Analyses) in which I took part during my PhD, designed a data architecture for storing multi-hazard data and disaster losses that supports multiple purposes and analyses such as loss accounting, Sendai Framework reporting, cost-benefit analysis, and disaster forensic investigation.*
What is clear is that this is not just a technology problem.

To achieve success by 2030 (the timeframe for achieving Sendai, and also the UN Sustainable Development Goals or SDGs), it is imperative that all stakeholders collaborate effectively, break down silos, share data, coordinate their efforts, demonstrate serious commitment, and implement appropriate policies. Even with the best IT tools at our disposal, these fundamental factors are essential for progress. This should be our primary focus for the coming decade.

Gareth: I appreciate your feedback on these points, Shubharoop and Marina. The points about data silos are ones that I have come across before, and I know it's not easy to simply make everything available to everyone, for different purposes. I do wonder about the potential for a better data exchange between the public and private sectors in this space. Thanks also, Marina, for the examples of work that is happening to improve the situation.

Ana: Just one more thing from me. I noticed on your website that you also use Earth observations for disaster post-recovery, could you tell us a little more about that?

Shubharoop: *Assessment of post disaster recovery is critical to develop, enhance and shape decisions and policies for communities to ensure a sustainable recovery process factoring in immediate and long-term needs of a community. We at ImageCat have worked on several milestone studies in the aftermath of major disasters to assess post disaster recovery of various sectors impacted by the events.*

One such study focused on a quantitative assessment of the housing sector recovery in the community of Punta Gorda in Florida after hurricane Charley in 2004. Several data sources were part of the assessment with remote sensing imagery being one of the key components. High resolution satellite image and aerial photos were used to assign each building a remote sensing damage and recovery scale developed for measuring and evaluating post-disaster community recovery.

After 2010 Haiti earthquake, we led a large research team which looked at community -scale damage and disruption in Haiti. The study gathered multiple types of quantitative and qualitative data to assess damage and disruption in the early recovery timeframe. Data included satellite and aerial imagery, GPS-referenced street-view video and ground photos, data from semi-structured interviews and community meetings. The study focused on seven communities and eleven sectors ranging including drinking water, energy/fuels, sanitation, healthcare etc. in the earthquake-affected area.

Gareth: Thank you very much for your time to discuss the work of ImageCat, Shubharoop and Marina. We look forward to seeing how your work continues to move forward.

Shubharoop: *It has been indeed a pleasure sharing our thoughts with you! I would like to thank and acknowledge the contributions of my colleagues at ImageCat who are involved in the research projects which Marina and I covered. Also, we would like to mention the specific contribution from Charles Huyck on the counterfactual thinking behind our work.*