Questions & Answers Part 1

Please type your questions in the Question Box. We will try our best to get to all your questions. If we don't, feel free to email Brock Blevins (brock.blevins@nasa.gov)

Question 1: How is it cost effective to actually retrofit when you have to spend the extra time and money on customizing specific requirements?
Answer 1: A benefit-cost analysis will determine whether a retrofit is cost-effective. The analyses will calculate the expected losses for the as-is (original) building and the expected losses for the retrofitted case. When the expected benefits (or reduction in losses) are greater than the retrofit costs, the retrofit is deemed cost effective. For example, if a seismic retrofit costs $10,000, but through analyses we expect a $20,000 reduction in losses, we can say the retrofit is cost effective and has a benefit-cost ratio of 2.0. BCRs (Benefit-Cost Ratio) greater than 1.0 are considered cost effective. The Benefit-Cost Analysis for FEMA looked at several different mitigation and building options, including buyouts (buying property and turning land into parks), retrofitting options, and building code enhancement. Standard retrofitting options, such as tying down mobile homes for hurricanes, or bolting foundations for earthquake retrofitting generally don't require site-specific customization that would add substantially to the cost. The study also looked at site-specific customized retrofits, such as hardening a room in schools and hospitals to resist tornados, or retrofitting high-value properties. These types of retrofitting projects are generally cost effective in high risk areas, particularly when the protection of life or avoidance of business interruption is considered.

Question 2: What would be the possibility of Exposure mapping (in terms of accuracy) of renewable energy to assess extreme events using EO data?
Answer 2: It is difficult to answer this question without having more detail about exactly what you are envisioning, but this is something people are doing. Used to assess transition risk. An example would be characterizing the prevalence of solar panels, or

the vulnerability/placement of alternative energy sources. The accuracy will depend on the specific application.

Question 3: Can you provide some articles related to how to measure building height and shade patterns in urban areas?
Answer 3: I am not aware of any papers looking at shade patterns. I recommend Google Scholar as a good source of discovering papers. Characterizing heat islands

Question 4: On slide 9, SAR was mentioned when talking about building height. Sentinel-1 data has a ground resolution of 10m. What would be the vertical accuracy when using this dataset for estimating the building height? Presuming I picked up correctly that Sentinel-1 SAR was used to find the building height.
Answer 4: The research mentioned was based on airborne data (3m as I recall) and the accuracy at any given location can be far off, but can be useful in understanding the general height pattern of buildings for the inference of structure type.

Question 5: In the step: "Estimate the Distribution of Building by Development Patterns: Identifying and Delineating Development Patterns", how much effort goes into this process and can it be automated? Is there a global dataset that has this information, or does it need to be calculated for each study area?
Answer 5: Automated segmentation algorithms can be applied, but it is best to tailor for specific applications. It will depend upon the scale of the work being done. The METEOR project by BGS has data for several developing countries. USGS Pager (urban and non-urban) and GEM have incorporated and published structural times by country for most countries, but they do not have a development pattern approach. The world housing encyclopedia.

Question 6: I live in Qatar, which is on the coast of the Arabian Gulf. Our region is generally extremely low risk in terms of natural disasters and thus we have tons of energy producing plants near the sea. Even though it is considered safe, we still need to take measures in the case of that 1 percent. What approaches would be appropriate to address the what-ifs?
Answer 6: If you are looking at power plants, a good place to start would be acquiring flood data that characterizes the 1% hazard (or more conservative) (there are international datasets such as these) and overlaying it with the facility locations. For

locations that are at risk, you should prioritize the acquisition of more detailed site specific data, and consider mitigation options. High valued facilities, relying on 1% may not capture the future risk as climate is changing.

Question 7: Nice to learn about ongoing projects in Nepal for identifying building heights, the country has scattered buildings in hills and mountains. How can I estimate the number of buildings in such terrains with scattered built-up patterns? Further, use of local resources like slates (rock) or wooden or bushy rooftops make it even more challenging to detect buildings.
Answer 7: This is actually an example we often use illustrating the limitations of EO data. It is very difficult to characterize in mountainous areas, specifically the mountains of Nepal. We have a L1 and L3 products. We have not focused on precisely looking at building heights in Nepal, only the general distribution of assets. The METEOR project (URL: https://maps.meteor-project.org/) led by BGS has data with an estimate, including some that integrates building footprints from OSM. OSM has building specific footprints, but will have the same limitations in some environments. You can't beat the human eye.

Question 8: When estimating raster cell population counts using building and other spatial datasets, have you come across known under-forest canopy populations that are undetectable by remote sensing? If so, how did you account for those counts?
Answer 8: Yes, this is a noted limitation of the analysis that needs to be recognized and discussed with clients. There are many approaches and the results based on the approaches result in very different population distributions. For example, note the difference in population distribution visible in the POPGRID application in Papa New Guinea. In our experience, we have distributed population hueristically based on signs of human activity (e.g., roads, agriculture, visible buildings, historical maps of tribes, cleared land). Being transparent in the limitations is important.

Question 9: On the slide Mapping Scheme Basics, a lot of different sources are mentioned. How much of the data is processed automatically and how much is done manually? I want to get an idea of how long it would take to create a view of the building composition in a middle-sized town in an agricultural focused semi-rural region (not highly developed).

Answer 9: These are great questions, and it is difficult to answer generally. For country-level analysis, we generally use semi-automated processing. If you are looking at a mid-sized town in a rural area, there may not be a lot of differentiation and you can isolate downtown and industrial areas or essential facilities in a few days. You might want to refer to local planning maps as a start. How much time you spend is generally informed by the level of risk and funding. If the town has very little risk, it may not be important. If there is significant risk, you might consider going to a building level analysis. It depends on the extent of the study.

Question 10: Are we going to get the case study pdf?
Answer 10: You can download the pdf of today's presentation from the Handouts section or from this training's webpage here: https://appliedsciences.nasa.gov/get-involved/training/english/arset-transforming-earth-observation-eo-data-building-infrastructure

Question 11: Is the Google Earth Engine source code available? Is it possible to analyze your own satellite data in Google Earth Engine (e.g., commercial satellite data), or can you only use data available in their catalogues?
Answer 11: Neither the source code or the data for Tunisia is open. You can upload your own data into GEE, or use any other image processing.

Question 12: Independent from the population density where we already have different open global raster datasets (WorldPop; Landscan; GHS), is there any GIS global layer indicating the settlement vulnerability considering the urban structures?
Answer 12: We don't think there are any GIS datasets.

Question 13: What is the success rate of the Tunisia case study and the limitations?
Answer 13: The goal was to have a view of the risk for the entire country for floods and earthquakes. We could only use the data that existed on hazards. Exposure data was used to geo-locate the vulnerability.

Question 14: How can we consider the uncertainty in assessing exposure and vulnerability?

Answer 14: Assessing uncertainty of vulnerability, we cover in Part 3.

Question 15: Morocco experienced an earthquake. How can I calculate damages post-earthquake? Any suggestions about data sources and tools?
Answer 15: Earthquake, calculate damage: Exposure where buildings are located, given vulnerability, what are the damages, and then the hazard maps. USGS has a shake map program, GIS data. Regional accuracy will vary. GEM for calculations.

Question 16: How do you deal with mixed forms of building structures? When I was in north Africa, there were a lot of mixed builds.
Answer 16: If in regards to mixed structural types, we try to find a vulnerability curve specific to those. We create development patterns to determine the distribution.

Question 17: Does hyperspectral satellite data make analysis better than using broader spectral images?
Answer 17: It coudn't hurt. In some cases, hyperspectral data may be able to indicate age and quality of roofs, for example, that may not be detectible in standard imagery. This is a great area for research.

Question 18: I live in the U.S. and am interested in doing this kind of work. What sort of companies and organizations are doing this type of work?
Answer 18: FEMA, USGS, NIBS, NOAA, and others are doing this type of work and research in this area. Many universities are very active in risk assessment. Private companies include Moody's, AIR/VERISK, CoreLogic, ImageCat, Aon, and other reinsurance brokers, reinsurers and insurance companies.

Question 19: Did you go on the ground in Tunisia at any point during the study or was it completely remotely assessed?
Answer 19: Completely remote. Available Google Streetview was used as well. In general, you can get more accurate data if you go into the field, but that may not be required, depending on the resolution of your vulnerability curves.

Question 20: Vulnerability is a composite of direct and indirect impacts. For example, a dam failure will create a flash flood, but the dam may fail due to 1. an

engineering problem, 2. extreme rainfall [Tunisia], or 3. An earthquake. But, can you really figure in secondary impacts in a vulnerability analysis?

Answer 20: There are many ways to consider secondary impacts in a risk analysis. Though the vulnerability may only address the dam itself, subsequent studies can look at the cascading effects. For example, Mike 11 can be used to examine the inundation from the dam breach, and given the velocity and depth of flooding, the subsequent building damage can be estimated, as well as the consequent casualties and economic disruption. It is quite important moving forward that the modeling community begin to focus on these indirect impacts, as they can overwhelm direct impacts. Areas that we are particularly aware of include long-restoration timelines that impact economies and the people that depend on them.