Questions & Answers Part 3

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 Amber McCullum (amberjean.mccullum@nasa.gov) or Juan Torres-Pérez (juan.l.torresperez@nasa.gov).

Question 1: How could I improve the accuracy percentage of the classification, since it was 83%?
Answer 1: There are a few ways you can improve a land cover classification. You could include more training data (ground-based "truth") into your model. You could also include additional data layers, for example, a digital elevation layer could be used alongside Landsat data to improve the accuracy of the land cover classes. This can be done in R or Google Earth Engine. You could also try out different land cover classification algorithms. We mentioned Random Forests, which is very common, but there are others you could explore too. Ground based information is the best way to improve accuracy.

Question 2: Do the seasons affect the nature of the results? Is there a specific date and criteria for estimating biodiversity in an area?
Answer 2: It depends, in regions that have clear vegetation green-up and senescence, such as in mid-latitude temperate forests, there is a clear change in the vegetation signature, so for example, the NDVI will be high in the summer and lower in the winter. Phenology is also important for understanding species movement, depending on the species of interest. If there are certain species that you know migrate depending on the phenological patterns of the vegetation, these seasonal changes can be very useful for mapping. We have a previous ARSET training on Phenology and also Species Distribution Modeling:

- https://appliedsciences.nasa.gov/join-mission/training/english/arset-understanding-phenology-remote-sensing
- https://appliedsciences.nasa.gov/join-mission/training/english/arset-species-distribution-modeling-remote-sensing

Question 3: Why does the extent of the ecosystem need 22 classes in one map? Will this cause an overlap in one map preview?
Answer 3: I am assuming the research team has a specific reason for these 22 classes in the map. The different land cover classes might be associated with different species,

which could be used for estimates of biodiversity, or for types of agriculture, where the products might be evaluated for estimates of economic production. These discrete types of land cover classes might also be useful for identifying the contribution of carbon sequestration in different ecosystems. The final ecosystem extent map is a combination of the first two maps, the land use/land cover and the ecosystem extent. The classes identified here were likely chosen based on what the team hoped to understand about the services of these ecosystems, but there are also other standardized approaches to land cover classification, such as work being done by the UN FAO, who works on the Land Cover Classification System (LCCS) and Land Cover Metalanguage (LCML). This was mentioned by Ken Bagstad during our last session.

Question 4: Regarding the Uganda report, a lack of ground-level spatial and temporal bushmeat hunting data that is not taken into account in this type of analysis seems to discredit the utility of this type of report. Your thoughts?
Answer 4: It is always valuable to have ground-based data, especially for creating a land cover classification, in order to estimate the accuracy and improve the accuracy.

Without the bushmeat data, it might be difficult for the team to estimate the value of that service to the country. However, there are likely many other ecosystem services the Ugandan team was considering, such as identifying ecosystem degradation, and conservation areas for tourism.

Question 5: How can Hyperspectral and SAR data be useful for evaluation of ecological services in a protected area using the InVEST model?
Answer 5: Hyperspectral and SAR data can be useful for creating a more-detailed land cover classification map, where you might be able to identify different vegetation species within a forest for example with hyperspectral data. The SAR data can be useful for identification of canopy cover, forest density, and tree height. These additional data could potentially provide more information on ecosystem health and even carbon sequestration. Depending on what you are valuing in the InVEST model, these inputs could be useful.

Question 6: How difficult is it to differentiate classes of perennial and plantation forest in Indonesia?
Answer 6: While this is not a type of analysis I have conducted, I would imagine that it depends on the structure and vegetation type of the perennial vs. plantation forest. If the dominant species in these ecosystems have a particular spectral signature, then they might be able to be differentiated using standard optical or hyperspectral data.

The data that might be most useful here however is SAR data, which would help you identify differences in forest structure, like canopy density, which is likely very different in perennial vs plantation forests as the plantation forests are likely uniform in their planting and less dense.

Question 7: Are there differences between land cover maps classification (until 2005 and after 2005) for Uganda? What is important peer attention in situations like that?
Follow up: In my question about Ugandan land cover maps classification my doubts are about the process. National Biomass Study produced maps until 2005 and after FAO produced maps. Are the process (or methods) equals? Are there differences in classification process (or method)? How is it possible to guarantee that the results are comparable?)

Answer 7: One of the key ecosystem changes identified was substantial reductions in the extent of natural ecosystems in Uganda, particularly for Forest (29% remaining) and Moist Savanna (32% remaining) ecosystems. The potential drivers for the changes in land cover include intermittent farming and plantation use with up to 3 to 4 million ha subject to change. These changes in land cover are significant because the areas subject to change will not be able to support the delivery of the range of ecosystem services that could otherwise be expected if there had been a stability in ecosystem type.

In regards to the follow-on question, it might be best to discuss the specifics with the researchers outlined in the report, as I have not been involved with the analysis myself nor can I comment on the accuracy of the National Biomass Study vs. the FAO classifications in this particular region. I will say that different classification schemes and available data do make it challenging to compare results across different time periods. Here is the report for more information: https://www2.unep-wcmc.org/system/dataset_file_fields/files/000/000/445/original/Ecosystem_Accounting_in_Uganda_Report_FINAL.pdf?1494865089

Question 8: In Value Ecosystem Services are the valuations corrected to sustainable practices? For example, it's through overfishing that a high value for fishing can be obtained. Are these figures corrected to value the ecosystem service at a sustainable level?
Answer 8: It likely depends on how the economic valuation is conducted for specific studies. Yes, there are many studies that capture the current catch and associated

values, regardless if the practices are sustainable into the future. Much of the value is placed on the current information. But there are approaches to use these market based approaches to encourage sustainable behaviors. With initiatives like ecosystem-based fisheries management, and ecosystem level requirements identified by groups like the Marine Stewardship Council are promoting this sustainability. Here is a paper that reviews the role of market-based instruments in protecting marine ecosystem services: https://www.sciencedirect.com/science/article/pii/S2212041621001145

Question 9: What kind of vegetation class mapping is currently powerful enough for evaluating ecosystem service with remote sensing?
Answer 9: I'm not sure I fully understand this question. But I will say that the type of maps you create should be based on the ecosystem of interest and what you hope to evaluate within your analysis. For example, if mangroves are an economically important type of ecosystem, you probably want to ensure you are accurately mapping that type of land cover. This might necessitate the use of optical and SAR data in tandem with ground based information to create a highly accurate map.

Question 10: Hello amazing effort for coral reef for coastal protection, can we have the contact of the researchers that performed that?
Answer 10: I have provided the links to three of the papers we mentioned in the coral reef section below.

- Costanza et al 2014: https://www.sciencedirect.com/science/article/abs/pii/S0959378014000685
- Ferrairo et al 2014: https://www.nature.com/articles/ncomms4794
- Storlazzi 2019 (US/Hawaii): https://pubs.er.usgs.gov/publication/ofr20191027
- Storlazzi 2021 (US/ Puerto Rico and FL): https://pubs.er.usgs.gov/publication/ofr20211054

Question 11: How is the urban heat model different than what i-tree does?
Answer 11: I-tree uses some constant values to predict heat distribution. We ran the model for every city based on their data (tree cover, land cover, building coverage, and surface temperature). This model connects surface temperature and trees via a hybrid regression. I am not totally familiar with i-tree, but I don't think they use these inputs.

Question 12: In my understanding, water bodies such as ponds and rivers also mitigate heat. How did you integrate water bodies in the heat mitigation model?
Answer 12: We did not include that. It would have brought more complexity and taken a long time to solve/run the model. Water bodies can also trap heat. The impact of

wind is also a potential variable. Both would be great additional variables, especially if the region of interest is smaller.

Question 13: Wouldn't you need the data on tree species to calculate rainfall interception? And could you do tree species classification with remote sensing?
Answer 13: Leaf Area Index is a proxy for species. All we care about is the area to store water. However, if you have species data, you will have a more accurate LAI as well as trunk shape/storage. So, more data is better if you have it, but we don't have a national tree species dataset.

Question 14: Based on time series spatio-temporal analysis, can we assess and predict future ecosystem service valuation? Are there any functional models or frameworks available for the same purpose?
Answer 14: In the urban accounts, we haven't developed such models, but since our models have the predictability power, you can potentially predict how future weather patterns can change the impact of trees.

Question 15: Was water quality data included in the Uganda Ecosystem Accounting example?
Answer 15: From a brief review of their report, I don't think water quality was included in this analysis. Here is a link to the report if you'd like more information: https://www2.unep-wcmc.org/system/dataset_file_fields/files/000/000/445/original/Ecosystem_Accounting_in_Uganda_Report_FINAL.pdf?1494865089

Question 16: Where can we find the details of the models discussed in the last presentation for rain and trees?
Answer 16: This paper: Heris et al. (2021)
https://www.sciencedirect.com/science/article/abs/pii/S2212041620301686

Question 17: Is possible to calculate loss of ecosystem services by deforestation in Amazonian region?
Answer 17: Yes! Here are a few references for more information:

- https://www.conservation.org/projects/natural-capital-in-the-amazon
- https://www.nature.com/articles/s41893-018-0175-0
- https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0268425

Question 18: Can someone use species distribution models, instead of expert knowledge?

Answer 18: Species Distribution models can be used within mapping and evaluating ecosystems services. There are also many large repositories of species occurrence data you can obtain from sources such as GBIF, iNaturalist, Map of Life, etc. that you can use within your models, depending on if there is publicly-shared occurrence data. We have a previous ARSET training on species distribution modeling here:

- https://appliedsciences.nasa.gov/join-mission/training/english/arset-species-distribution-modeling-remote-sensing