Data Collection from Mobile Phones Using Open Data Kit (ODKCollect) for field validation of satellite-derived data products

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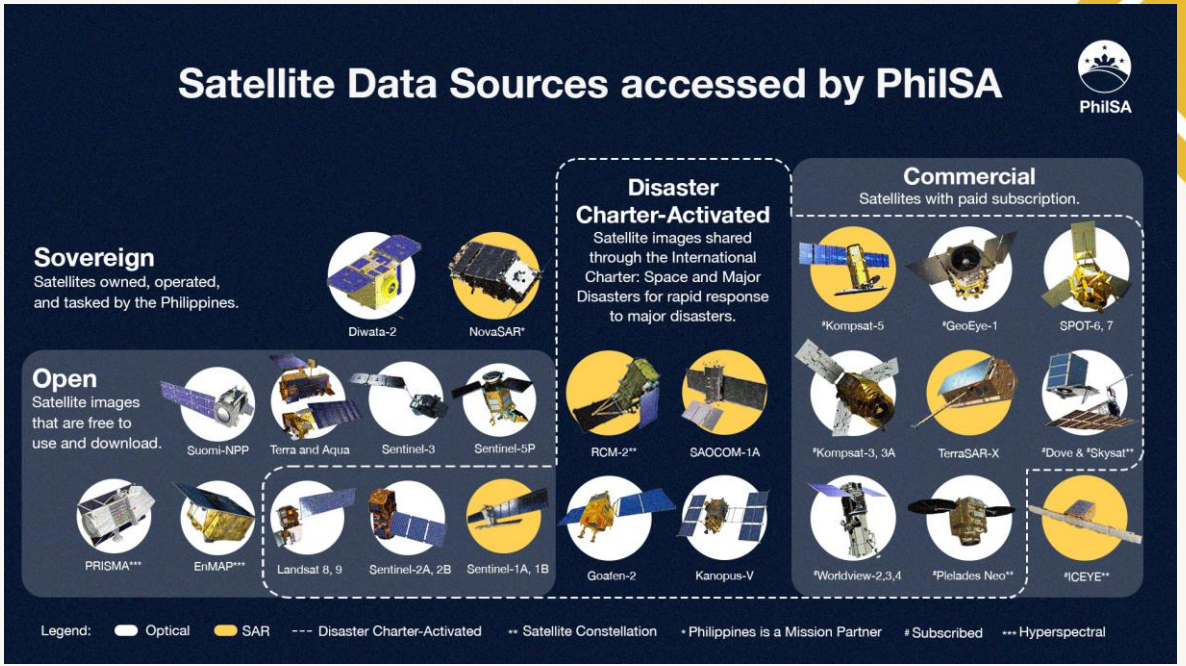
Satellite Data

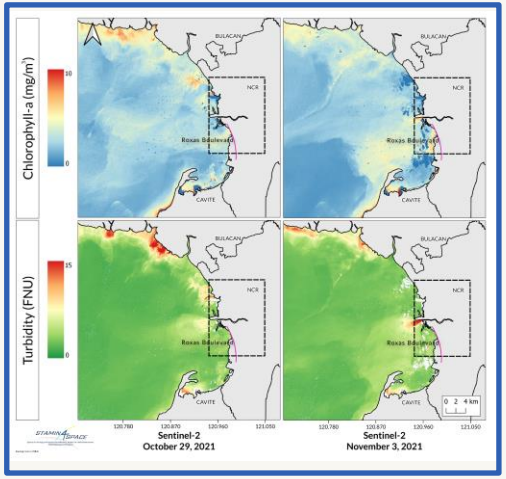
Importance

- Earth Observation and Monitoring
- Mapping
- Research and Development, Policy-making, and Disaster Risk Reduction Management

Satellite Data Available in the Philippines:



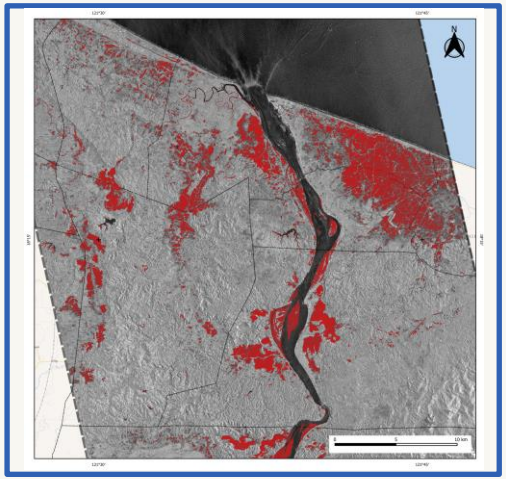
Applications of Satellite Data



Assessing Water Quality

Optical Image

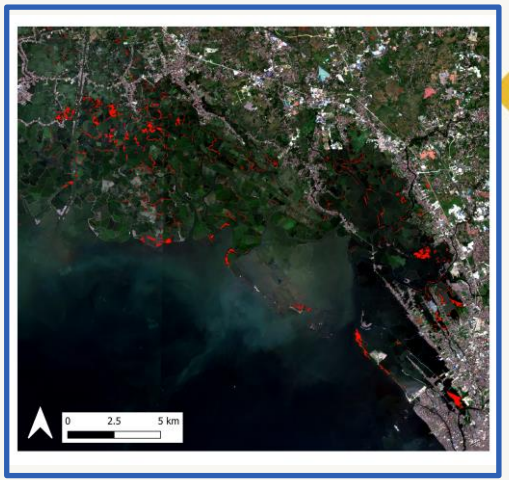
Satellite: Sentinel-2
Accessed via: STAMINA4Space
Capture dates: 29 October 2021 and 03 November 2021
Resolution: 30m
Basemap: PhilGIS, Google Earth



Flood Mapping

Synthetic Aperture Radar Image

Satellite: ICEYE
Accessed via: PhilSA
Capture dates: 01 November 2022
Resolution: 3m
Basemap: OpenStreetMap

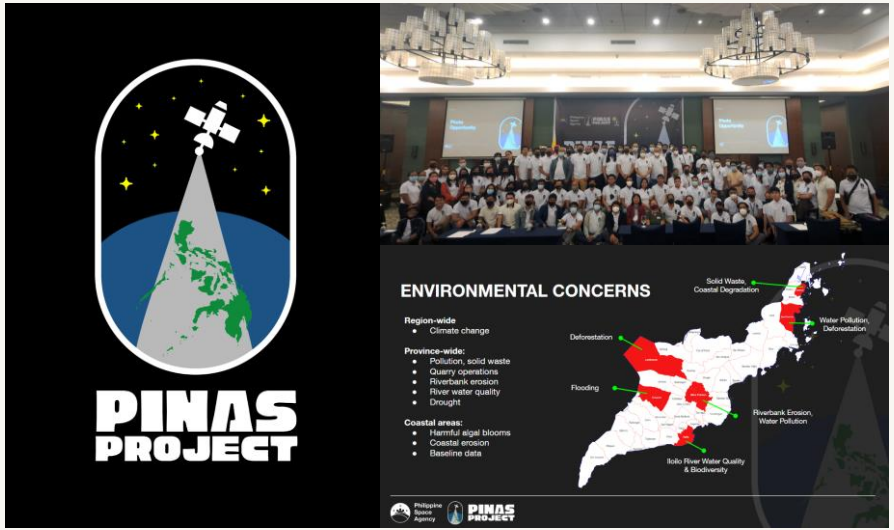


Mangrove Detection

Optical Image

Satellite: Sentinel-2
Accessed via: Google Earth Engine
Capture dates: 01 October 2021 to 23 October 2022
Resolution: 10m

PINAS



PhilSA Integrated Network for Space-Enabled Actions towards Sustainability

PINAS Network

- The PINAS project envisions a community empowered through space data mobilization wherein the full value chain of space data will be utilized. It envisions to be an active network of institutions and people working together toward sustainability using space data and information.

Mangrove Validation thru Citizen Science

BAGONG PILIPINAS

CMEMP AGOS NG BUHAY

CITIZEN SCIENCE FOR MANGROVES

MANGROVE MAP VALIDATION

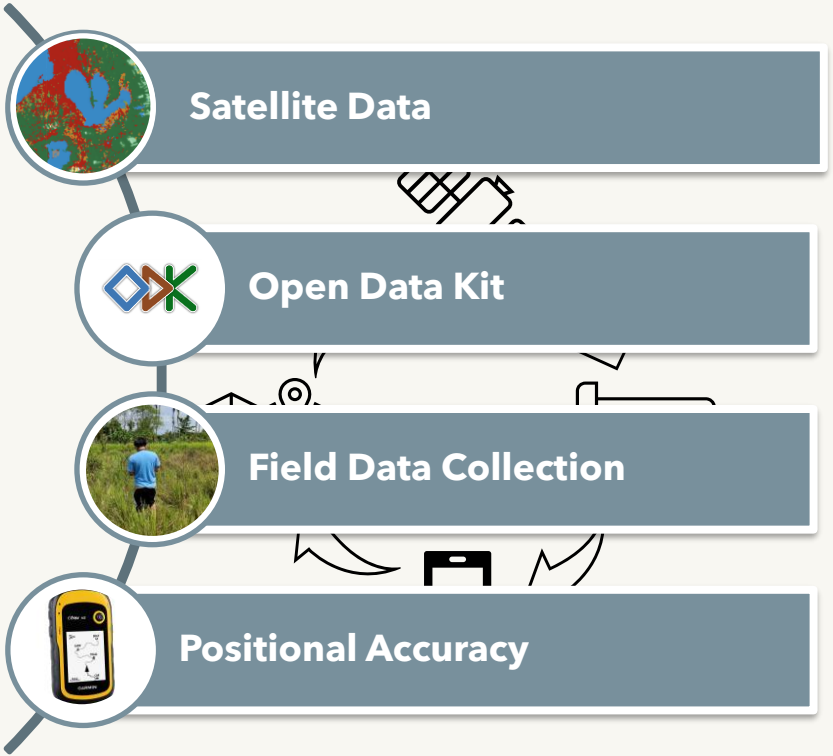
Data and Methodology

Problems

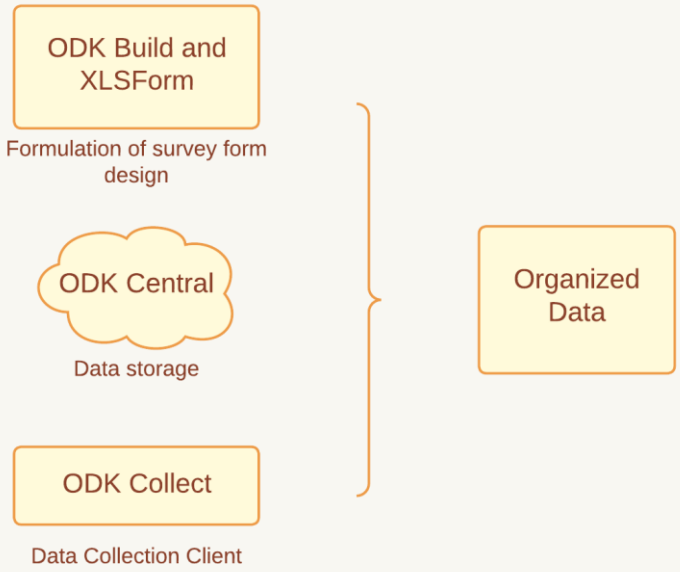
- Calibration and validation of maps
- Efficient field data collection methods

Objective

- Utilize ODK to develop a method for satellite data validation.
- Investigate the positional accuracies of the mobile phone's built-in location services used by ODK.



Open Data Kit (ODK)



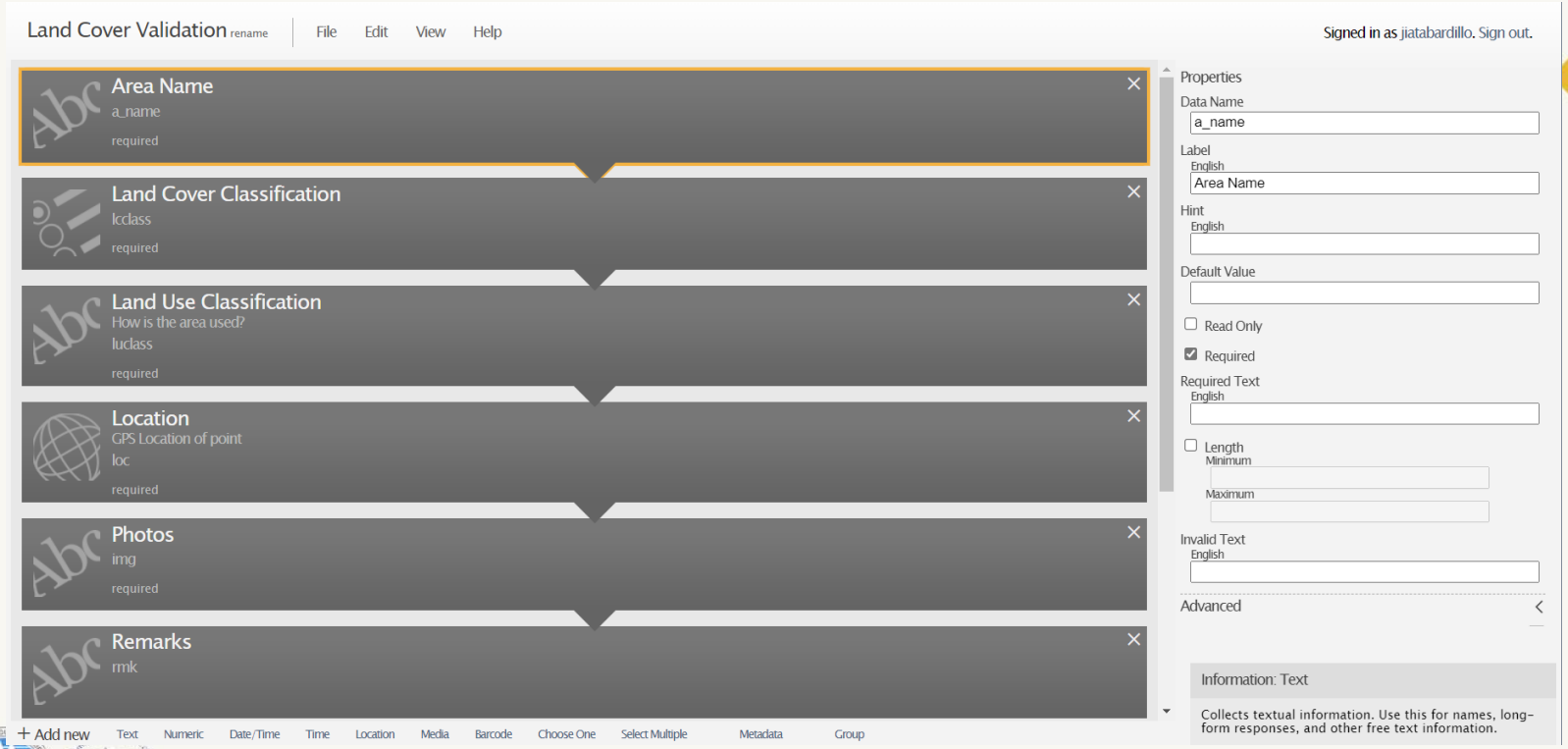
Open Data Kit System Architecture

- Platform for open-source tools designed to acquire and manage collected data
- Standard workflow: Create Forms, Manage Users, Collect Data

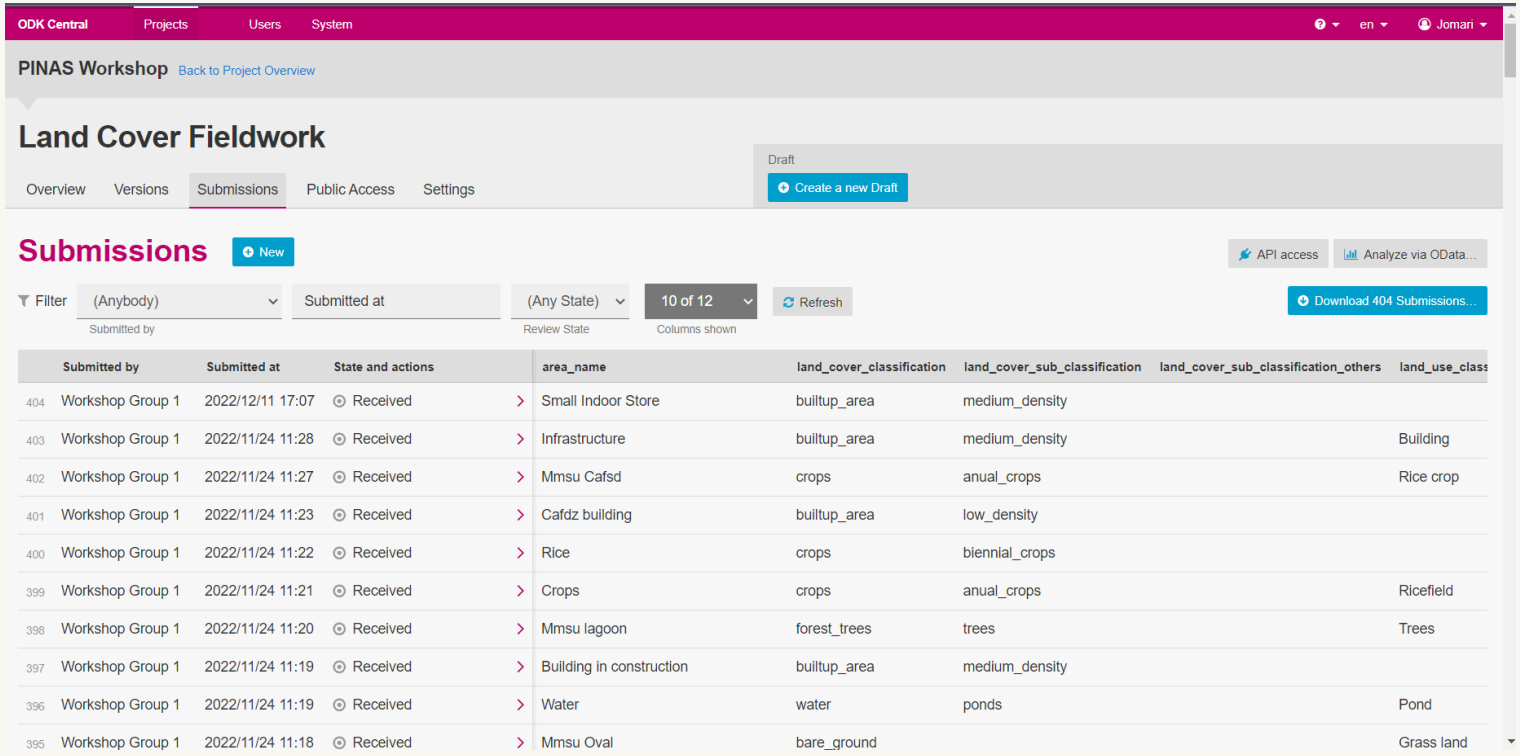
Why ODK?

- Digital!
- Supports various Q&A formats for various needs
- Built-in positioning capabilities
- Filling of surveys available even without internet

Open Data Kit System Architecture
ODK Build



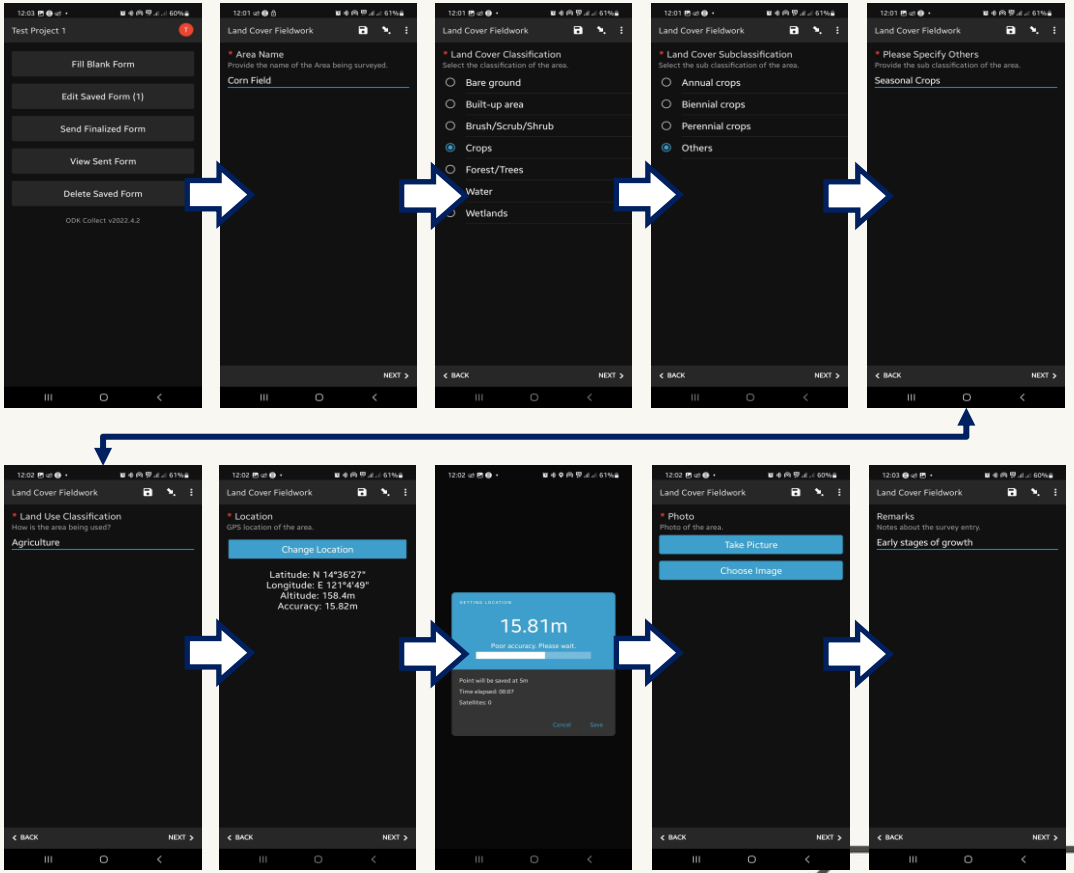
Open Data Kit System Architecture
ODK Central



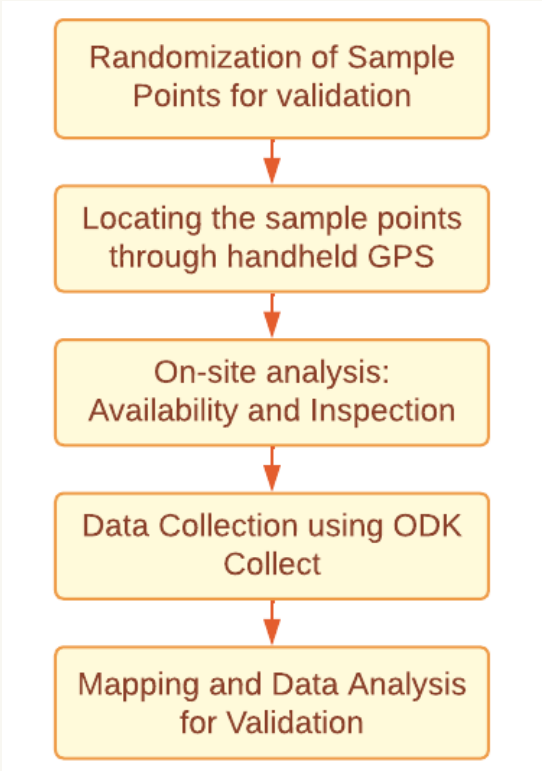
	Submitted by	Submitted at	State and actions	area_name	land_cover_classification	land_cover_sub_classification	land_cover_sub_classification_others	land_use_class
404	Workshop Group 1	2022/12/11 17:07	Received	Small Indoor Store	builtup_area	medium_density		
403	Workshop Group 1	2022/11/24 11:28	Received	Infrastructure	builtup_area	medium_density		Building
402	Workshop Group 1	2022/11/24 11:27	Received	Mmsu Cafsd	crops	anual_crops		Rice crop
401	Workshop Group 1	2022/11/24 11:23	Received	Cafdz building	builtup_area	low_density		
400	Workshop Group 1	2022/11/24 11:22	Received	Rice	crops	biennial_crops		
399	Workshop Group 1	2022/11/24 11:21	Received	Crops	crops	anual_crops		Ricefield
398	Workshop Group 1	2022/11/24 11:20	Received	Mmsu lagoon	forest_trees	trees		Trees
397	Workshop Group 1	2022/11/24 11:19	Received	Building in construction	builtup_area	medium_density		
396	Workshop Group 1	2022/11/24 11:19	Received	Water	water	ponds		Pond
395	Workshop Group 1	2022/11/24 11:18	Received	Mmsu Oval	bare_ground			Grass land

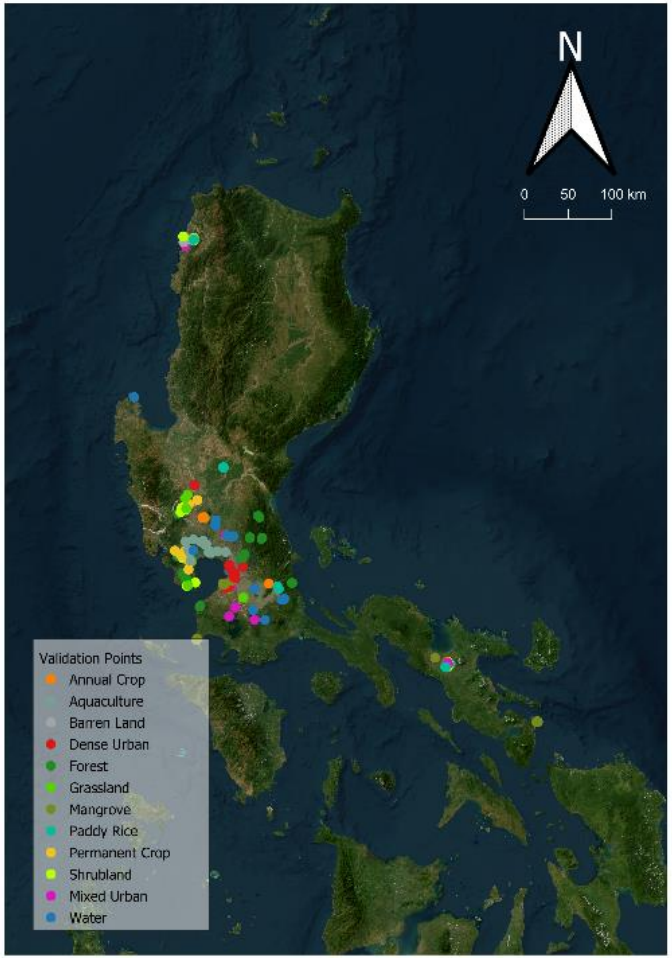
Open Data Kit System Architecture

ODK Collect



Map validation workflow using ODK





Results

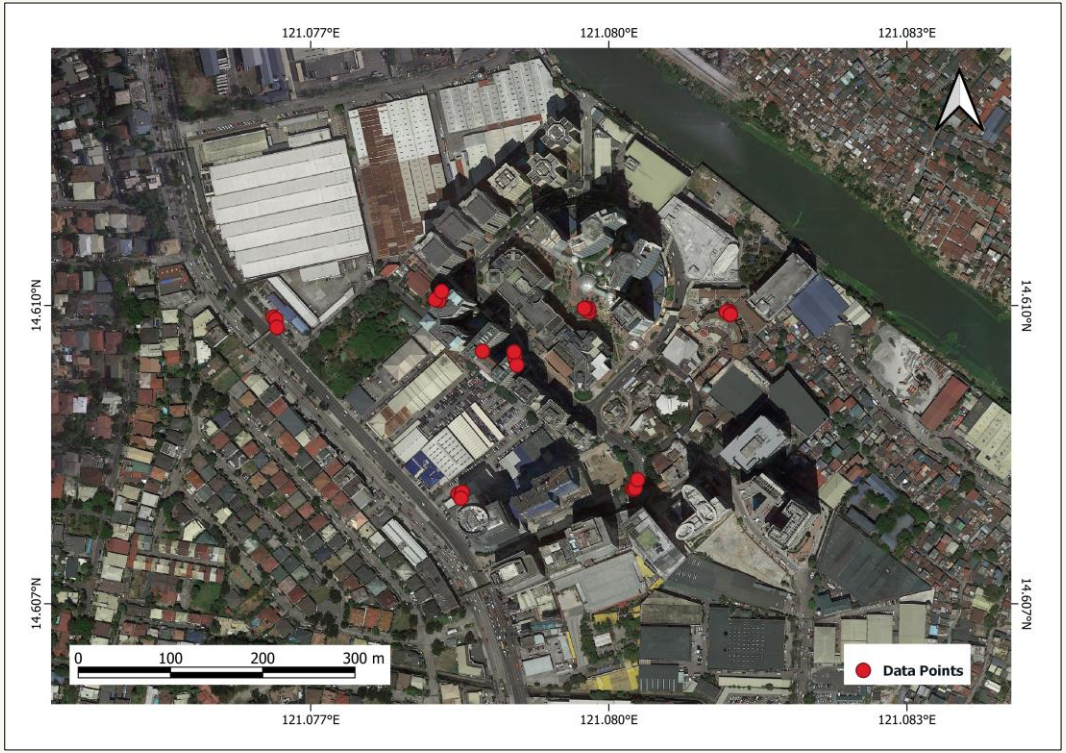
Land cover class	F1-score	Recall	Precision
Annual crop	88.0	76.9	83.3
Aquaculture	88.2	88.2	88.2
Barren land	71.4	80.0	64.5
Dense Urban	96.2	100.0	92.6
Forest	86.4	82.6	90.5
Grassland	69.8	88.2	57.7
Mangrove	96.6	93.3	100.0
Paddy Rice	87.5	97.2	79.5
Permanent Crop	71.8	66.7	77.8
Shrubland	66.7	59.5	75.9
Mixed Urban	85.1	74.1	100.0
Water	90.9	88.2	93.8

Results

Positional Accuracies in Rural Areas

- Average accuracy attained from the field is 4.422m

Results



Positional Accuracies in Urban Areas

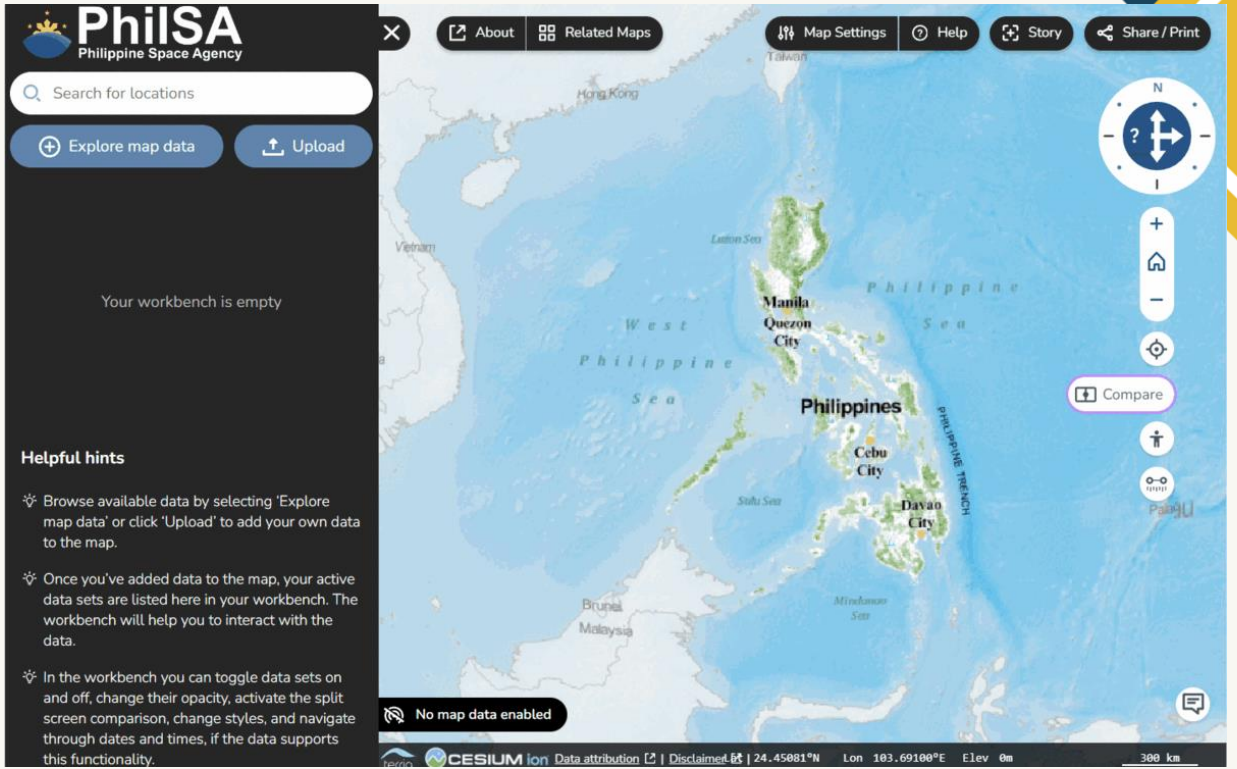
- Overall average accuracy attained from the field is 5.433m

Site	Accuracy (m)			
	Xiaomi Poco F3	Xiaomi Blackshark 5 Pro	Samsung Galaxy A52s 5G	Samsung Galaxy Note 7 Fan Edition
1	6.337	6.323	6.277	12.085
2	5.187	4.845	3.863	6.724
3	3.9	3.881	3.9	6.941
4	3.9	4.693	6.474	5.454
5	4.222	3.9	3.9	6.174
6	3.959	4.721	3.881	8.151
7	4.545	6.635	4.099	7.142
Mean	**4.579**	**4.999**	**4.628**	**7.524**

Visualization

A robust platform designed to revolutionize space data access for institutions and citizens.

PhilSA's initiative to improve public access and resource-sharing in space-related endeavors (Section 8, RA 11363)



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Conclusion

Limitations and Recommendations

ODK is a great tool for collecting and managing field validation data.

- Versatile, provides wide range of survey inputs, easy to manage & organize data.
- Open-source, robust, rapid.
- Provides enough accuracy for most open-source earth observation data such as Sentinel-2 & Landsat Imagery for validation.

For this study, both environments achieved sufficient accuracy to be able to validate medium resolution satellite data.

Limitations

- ODKCollect app is for Android mobile phones only as of now.
- Positional accuracy dependent on built-in GPS capability of mobile device.
- Photos captured without orientation or landmarks might be misleading due to location offset.

Recommendations

- Use of low-cost GNSS/commercial GNSS devices to complement data collection.
- Integration to online platforms such as the Space Data Dashboard for visualization and improved public access
- Application in disaster management (DRR)

Contact the Philippine Space Agency

https://www.facebook.com/PhilSpaceAgency

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https://www.linkedin.com/company/philspaceagency/

https://philsa.gov.ph/

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References

[1] Q. Zhao *et al.*, "An Overview of the Applications of Earth Observation Satellite Data: Impacts and Future Trends," *Remote Sens.*, vol. 14, no. 8, pp. 1–18, 2022, doi: 10.3390/rs14081863.

[2] U. Nations, O. For, and O. Space, "OFFICE FOR OUTER SPACE AFFAIRS INTERNATIONAL EFFOR TS USING SPACE FOR CLIMATE AC TION".

[3] D. Phiri, M. Simwanda, S. Salekin, V. R. Nyirenda, Y. Murayama, and M. Ranagalage, "Sentinel-2 data for land cover/use mapping: A review," *Remote Sens.*, vol. 12, no. 14, 2020, doi: 10.3390/rs12142291.

[4] G. A. Sanchez-azofeifa, M. Kachmar, and M. Kalacska, "Chapter 16 EXPERIENCES IN FIELD DATA COLLECTION In Support of Land Use and Land Cover Change Classification".

[5] N. Kishi, "Satellite Data and Crowdsourcing," *Space Policy*, vol. 56, p. 101423, 2021, doi: 10.1016/j.spacepol.2021.101423.

[6] P. Macharia, S. Masyuko, R. Bosire, D. Katz, C. Farquhar, and B. Weiner, "Implementing open data kit integrating barcode- based client identification in HIV testing and linkage to care : A user-centered design," 2021.

[7] S. Maleghemi, B. E. Bassey, B. George, A. Usman, and K. Anthony, "Improving Acute Flaccid Paralysis (AFP) Surveillance Performance in South Sudan : The Contribution of Open Data Kit Mobile Data Collection Technology," vol. 7, no. 1, pp. 11–15, 2019, doi: 10.12691/ajeid-7-1-3.

[8] S. A. O. Wamwenje, I. I. Wangwe, N. Masila, C. K. Mirieri, L. Wambua, and B. W. Kulohoma, "Community-led data collection using Open Data Kit for surveillance of animal African trypanosomiasis in Shimba hills, Kenya," *BMC Res. Notes*, vol. 12, no. 1, pp. 1–6, 2019, doi: 10.1186/s13104-019-4198-z.

[9] A. Signore, "Mapping and sharing agro-biodiversity using Open Data Kit and Google Fusion Tables," *Comput. Electron. Agric.*, vol. 127, pp. 87–91, 2016, doi: 10.1016/j.compag.2016.06.006.

[10] S. F. Campus, R. Scotti, I. Piredda, I. Murgia, A. Ganga, and F. Giadrossich, "The open data kit suite, mobile data collection technology as an opportunity for forest mensuration practices," *Ann. Silvic. Res.*, vol. 44, no. 2, pp. 86–94, 2020, doi: 10.12899/asr-1852.

[11] T. Ouma *et al.*, "Open data kit (ODK) in crop farming: mobile data collection for seed yam tracking in Ibadan, Nigeria," *J. Crop Improv.*, vol. 33, no. 5, pp. 605–619, 2019, doi: 10.1080/15427528.2019.1643812.

[12] D. Ichwana and T. Juhana, "Implementation of Mobile Data Collection System for Disaster Rapid Emergency Response System Using Open Data Kit," *2018 Int. Conf. Inf. Technol. Syst. Innov. ICITSI 2018 - Proc.*, pp. 485–490, 2018, doi: 10.1109/ICITSI.2018.8695950.

[13] UNESCO, "Biosphere Reserves", [Online]. Available: https://en.unesco.org/biosphere/aspac/palawan

[14] Philippine Statistics Authority, "Palawan: Population Rose to Three Quarter of a Million (Results from the 2000 Census of Population and Housing, NSO)", [Online]. Available: https://psa.gov.ph/population-and-housing/node/2252#:~:text=Puerto Princesa City was the most populated municipality&text=This registered a population of,of the total provincial population.

[15] C. F. Brown *et al.*, "Dynamic World , Near real-time global 10 m land use land cover mapping," pp. 1–17, 2022, doi: 10.1038/s41597-022-01307-4.

[16] "Open Data Kit (ODK) Documentation." https://docs.getodk.org/

[17] "Mobile phone reviews, news, specifications." https://www.gsmarena.com/