Mapping the African Manufacturing Landscape Using Geospatial Data to Enhance Equitable Manufacturing: An Exploratory Analysis in Ghana

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Introduction

Accessible and equitable manufacturing and distribution of diagnostics, drugs, and vaccines continues to be a top priority in Africa. Using geospatial data to establish a robust and detailed understanding of transport networks for these commodities can provide critical support for African priorities. Combining location (e.g. coordinates) and attribute information (e.g. object/event characteristics), geospatial data has the potential to boost transparency and equity in African pharmaceutical manufacturing, leading to more reliable access to health commodities.

Materials and Methods

Using publicly available data, Ghana, with a rapidly developing pharmaceutical sector, served as a pilot country for this analysis. A 2022 list of licensed manufacturers published by Ghana FDA was selected as the exploratory dataset. UN adjusted 2020 population count data with 100- meter resolution was obtained from WorldPop. Manufacturer to population accessibility utilizing fixed-wing delivery drone systems was calculated using geospatial methods. ArcGIS Pro was used to map and provide preliminary analyses.

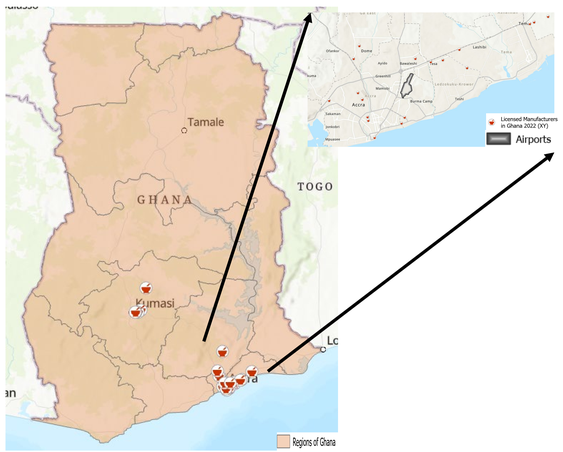

Figure 2. Ghana FDA registered pharmaceutical manufacturers overlayed on Ghana regional divisions.
Inset: Pharmaceutical manufacturers in the Greater Accra Region with airport highlighted.

FEATURES	Capable of carrying loads of up to 1.75 kilograms. Round trip range of 160 kilometers. Flies 4x faster than average quadcopter drones and serves area 200x as large.
HEIGHT	N/A cm | N/A in
LENGTH	218 cm | 86 in
WIDTH	330 cm | 130 in
WEIGHT	21 kg | 46 lb
SPEED	128 km/h | 79.5 mph (top speed), 101 km/h (cruising speed)

Figure 1. Image and specifications of Zipline's fixed wing drone system. The 160 km round trip range was utilized in this pilot to project theoretical coverage areas.

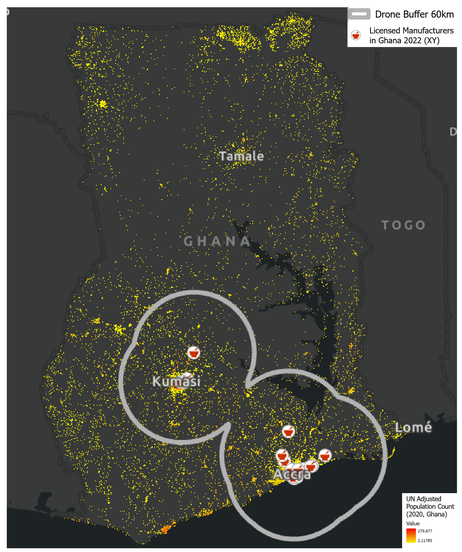

Figure 3. Theoretical drone delivery range of manufacturers overlayed on population density map of Ghana. Population raster resolution is 100 meters. Buffer zone radius is 60 km. Data obtained from WorldPop and Zipline.

Sources: ESRI, OSM, WorldPop, Ghana Open Data Initiative, Ghana FDA, Zipline

Results and Discussion

Of 32 licensed pharmaceutical manufacturers as identified in the data set, 26 were mappable. Pharmaceutical manufacturers were concentrated in the Greater Accra Region (n=20). Four facilities were in the Ashanti Region, and the remaining 2 in the Eastern Region. No manufacturers were identified in Northern Ghana. Manufacturers were generally located near airports, with the average distance from a facility to an airport being 12.467 km (median 7.6 km, min 2.21, max 41.22 km). Roughly 16.9 million, or roughly half of Ghana's total population were identified within drone delivery range of a licensed pharmaceutical manufacturer. 875 health facilities were within 14.7 km of a pharmaceutical manufacturer. The median distance from a health facility to manufacturer was 86.1 km.

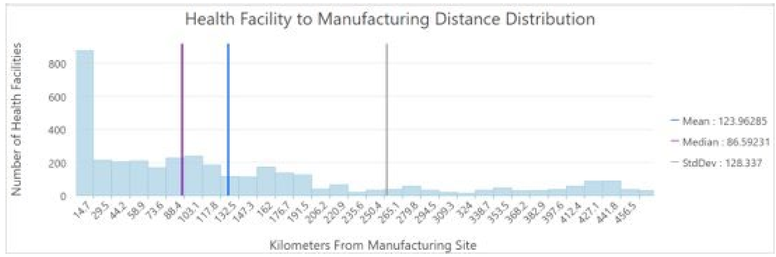

Figure 4. Distances of health facilities from a manufacturing facility. Health facility locations and types were obtained through the Ghana Open Data Initiative.

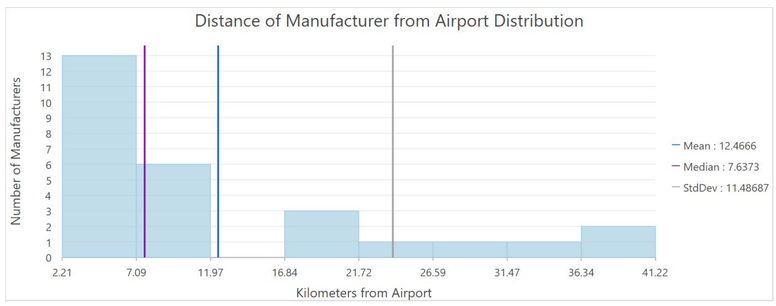

Figure 5. Distances of manufacturing facilities from an airport or airstrip. Airport polygons were sourced from OSM databases.

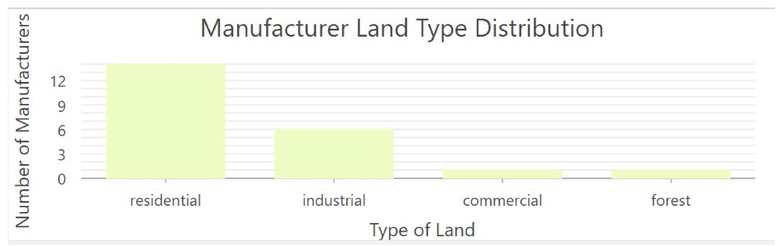

Figure 6. Type of land utilized by manufacturing facilities. Land type was obtained from OSM databases.

Strengths and Advantages

- Novel analysis
- Public health application
- Compliments priorities related to access and equity

Limitations and Opportunities

- Data availability
- Standardization/classification of variables (e.g. "manufactures")

Conclusion

Our pilot highlights the potential for geospatial data analyses to provide critical information resulting in improved commodities and health accessibility. Additional analyses are warranted to further map primary transport routes (e.g. road/air transport), first within Ghana and then to and within other countries in the Economic Community of West African States. Exploration of complete data sets for analyses and standardization of definitions are warranted.