

Report: A Plan to Expand Cell Tower Performance in Los Angeles County

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UCLA GIS 181B

Introduction

This report aims to, using the provided data pertaining to Los Angeles County, decide on the most effective option out of three for improving cellular tower performance in LA. The options analyzed were: (1) install three additional cell towers at optimal locations, (2) increase all towers' heights by 10 meters, and (3) increase each tower's signal range by 5km. Using GIS techniques, viewshed analysis was conducted to examine each of the three options, ultimately leading this analyst to recommend that the budget for improving cell tower performance in LA County be spent towards increasing the range of all towers by 5km. This is the best option of the three, in that it increases the area covered cellularly in LA County by the most significant amount.

Procedure

The first step to yield useful results, was to perform viewshed analysis on the provided data layers. This entailed editing fields in the provided [cell tower location shapefile](#) in order to properly reflect cell towers in LA County. Based on the original file, a new shapefile was generated for the current cellular coverage in LA, as well as a new file for each of the three upgrade options. The field values used for these files are found in the appendix. For option 1, the optimal location for the three new towers was determined via examination of the viewshed results for the current cellular coverage in LA. Large spots lacking coverage were high priority locations for new towers, which were then added manually by editing the shapefile. Subsequently, viewshed analysis was conducted on each option using the [DEM Elevation raster](#) in order to yield the coverage map for each. Once all viewshed layers were complete, the data for LA County was extracted using the [LA County Boundary shapefile](#), which was converted to a polygon layer for this purpose. The raster files resulting from this process were then analyzed in order to determine the coverage data found in Table 1. These rasters were also applied in Maps 1, 2, 3, and 4 to communicate qualitative information about where coverage areas differ.

Analysis

While every upgrade option would clearly be an improvement over the current cellular coverage in LA County, Figures 5 and 6 make it clear that increasing each cell tower's range by 5km is the most effective improvement. This option results in a coverage of roughly 7.9 million m², up from the current coverage of ~7.4 million m². Shown in Figures 1-4, that's an increase of ~4%, twice as effective as the other two options' increases of ~2% each. By coverage alone, this is the best choice. Option 2, the increase in height, is objectively worse than option 3 for this reason. However, there is an argument that the coverage provided by option 1 is more qualitatively useful. This is because the new towers would provide coverage to areas with relatively high population density, making more of an impact. In contrast, much of the new area covered by option 3 is located in mountainous areas with low population density. Realistically, installing three new towers might also require less work than upgrading every tower in the county. Despite these points, given that option 3 results in more than double the coverage of the other two, this analyst still recommends it as the superior choice in this scenario.

Conclusion

In conclusion, both the installation of three new towers and the increase of each towers' range by 5km are viable options to expand cell tower performance in LA County, but the range increase will result in more coverage and is thus superior.

Appendix

This Appendix contains the following maps, figures, and information, in order:

- ❖ Values Used for Viewshed Analysis
- ❖ **Map 1:** Los Angeles County Cell Tower Coverage, Current
- ❖ **Map 2:** Los Angeles County Expanded Cell Tower Coverage, with 3 New Towers Added
- ❖ **Map 3:** Los Angeles County Expanded Cell Tower Coverage, all Tower Heights Increased by 10 Meters
- ❖ **Map 4:** Los Angeles County Expanded Cell Tower Coverage, all Tower Ranges Increased by 5km
- ❖ **Table 1:** Area Coverage Statistics for Current LA Cell Coverage and Three Potential Coverage Expansions
- ❖ **Figure 1:** Cell Coverage Area in Los Angeles County with 3 New Towers
- ❖ **Figure 2:** Current Cell Coverage Area in Los Angeles County
- ❖ **Figure 3:** Cell Coverage Area in Los Angeles County, 10m Taller Towers
- ❖ **Figure 4:** Cell Coverage Area in Los Angeles County, Tower Range Increased by 5km
- ❖ **Figure 5:** Total Coverage Area (m^2)
- ❖ **Figure 6:** Uncovered Area (m^2)

Values Used for Viewshed Analysis

Current Cell Coverage:

OFFSETA = 40 (meters, representing cell tower height)
 OFFSETB = 1.4 (meters, representing average human height).
 AZIMUTH1 = 0
 AZIMUTH2 = 360
 VERT1 = 90 (max)
 VERT2 = -90 (min)
 RADIUS1 = 0
 RADIUS2 = 30000 (30 km)

Option 1: Three Additional Towers:

OFFSETA = 40 (meters, representing cell tower height)
 OFFSETB = 1.4 (meters, representing average human height).
 AZIMUTH1 = 0
 AZIMUTH2 = 360
 VERT1 = 90 (max)
 VERT2 = -90 (min)
 RADIUS1 = 0
 RADIUS2 = 30000 (30 km)

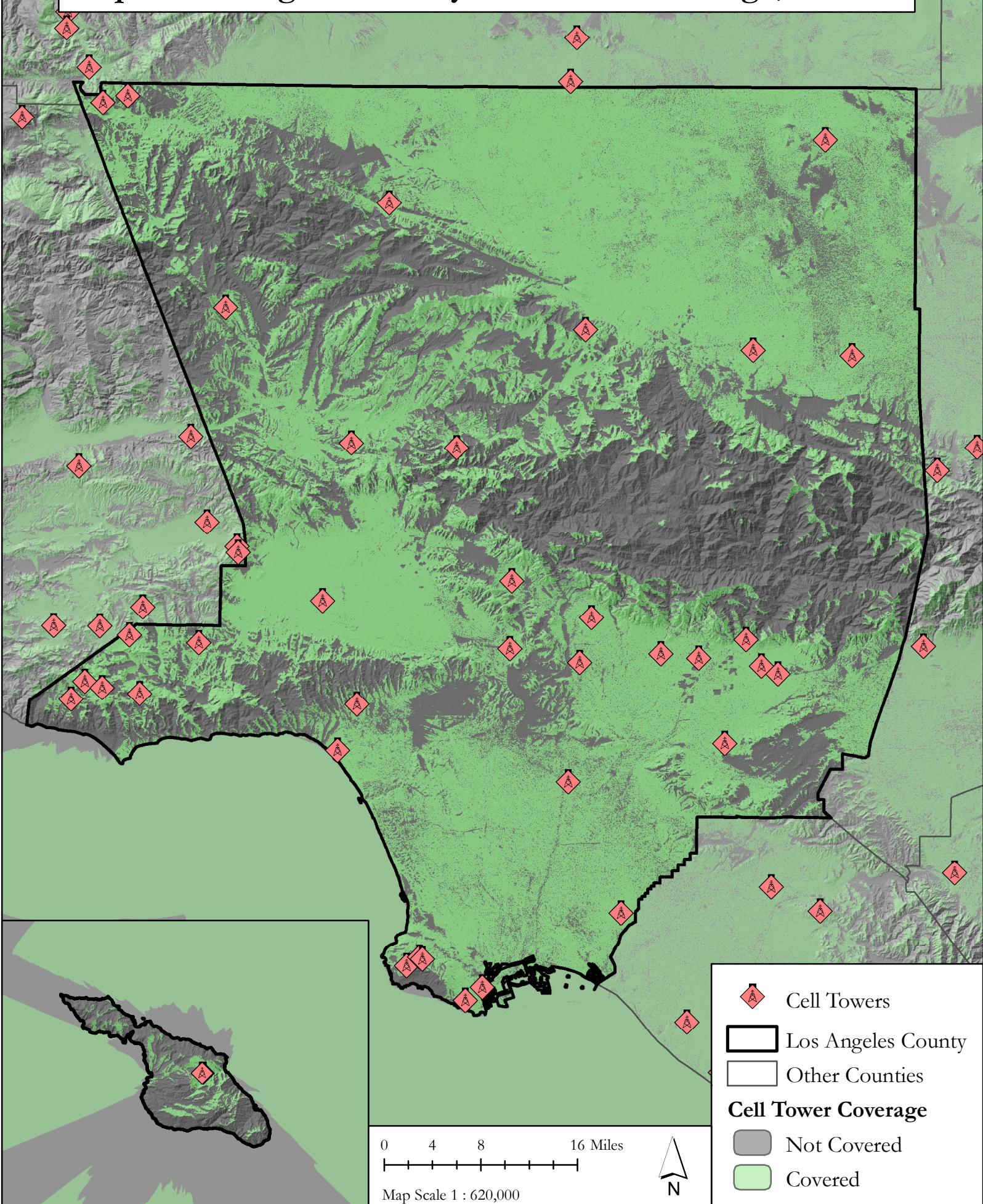
Option 2: Increased Height:

OFFSETA = 50 (meters, representing cell tower height)
 OFFSETB = 1.4 (meters, representing average human height).
 AZIMUTH1 = 0
 AZIMUTH2 = 360
 VERT1 = 90 (max)
 VERT2 = -90 (min)
 RADIUS1 = 0
 RADIUS2 = 30000 (30 km)

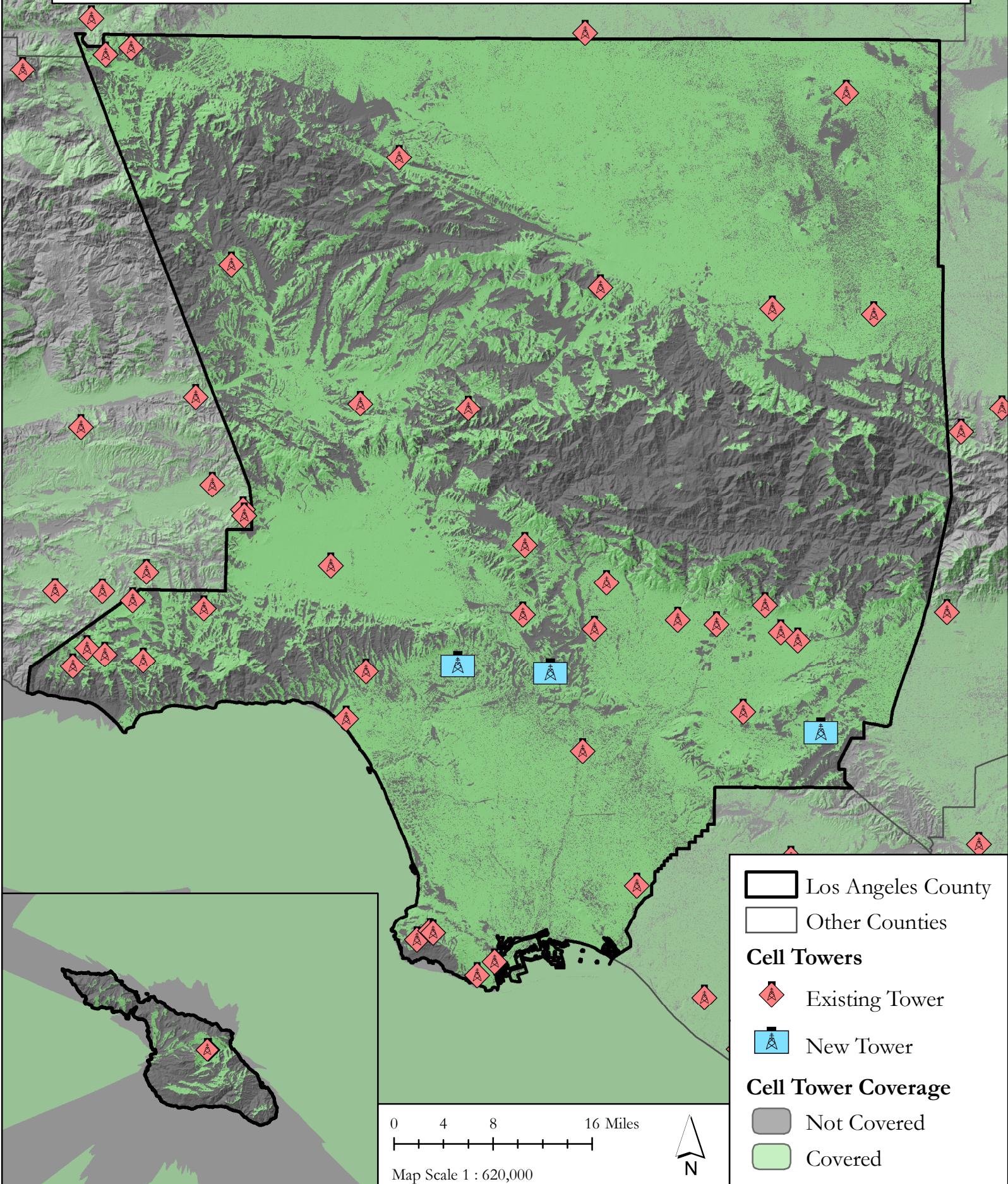
Option 3: Increased Range:

OFFSETA = 40 (meters, representing cell tower height)
 OFFSETB = 1.4 (meters, representing average human height).
 AZIMUTH1 = 0
 AZIMUTH2 = 360
 VERT1 = 90 (max)
 VERT2 = -90 (min)
 RADIUS1 = 0
RADIUS2 = 35000 (35 km)

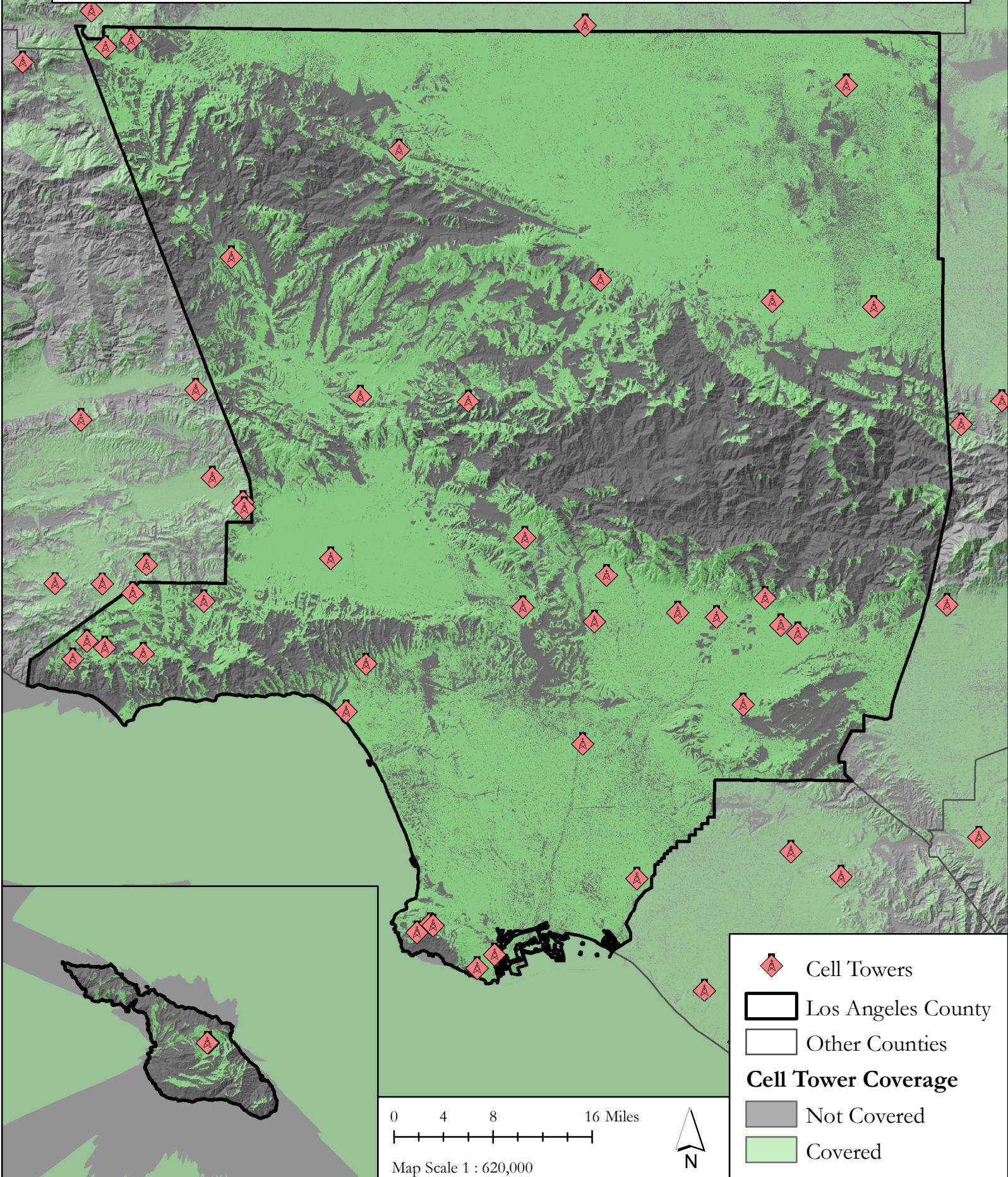
Map 1: Los Angeles County Cell Tower Coverage, Current



Map 2: Los Angeles County Expanded Cell Tower Coverage, with 3 New Towers Added



Map 3: Los Angeles County Expanded Cell Tower Coverage, all Tower Heights Increased by 10 Meters



Map 4: Los Angeles County Expanded Cell Tower Coverage, all Tower Ranges Increased by 5km

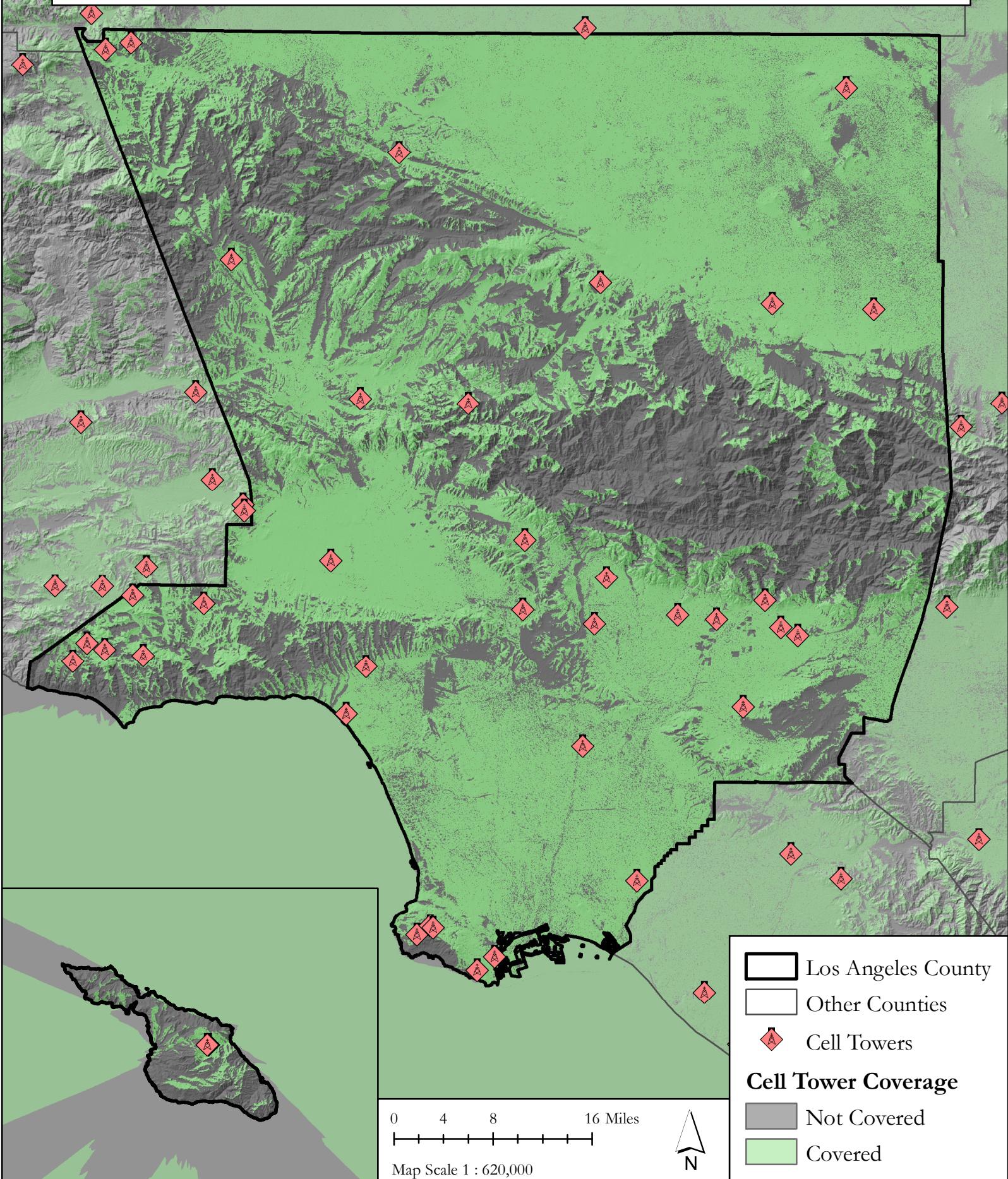


Table 1: Area Coverage Statistics for Current LA Cell Coverage and Three Potential Coverage Expansions

| | Area Not Covered (m ²) | Area Covered (m ²) | Area Not Covered (%) | Area Covered (%) | Total Area (m ²) |
|----------------------------|------------------------------------|--------------------------------|----------------------|------------------|------------------------------|
| Current Coverage | 5575342 | 7443850 | 43% | 57% | 13,019,192 |
| 3 Additional Towers | 5383868 | 7635324 | 41% | 59% | 13,019,192 |
| 10m Taller Towers | 5384787 | 7634405 | 41% | 59% | 13,019,192 |
| 5km Longer Range | 5116548 | 7902644 | 39% | 61% | 13,019,192 |

■ Not Visible (43%) ■ Visible (57%)

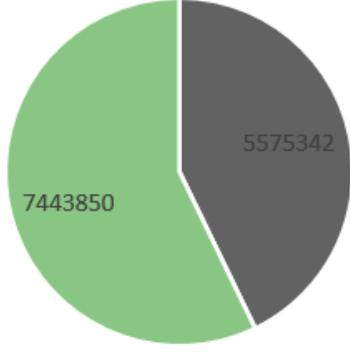


Fig. 1: Current Cell Coverage Area in Los Angeles County

■ Not Visible (41%) ■ Visible (59%)

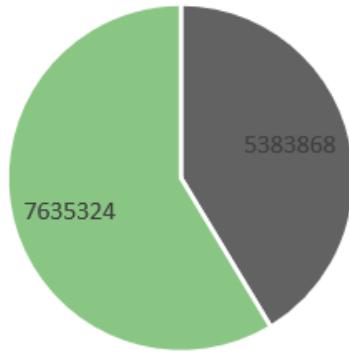


Fig. 2: Cell Coverage Area in Los Angeles County with 3 New Towers

Vertical (Category) Axis

■ Not Visible (41%) ■ Visible (59%)

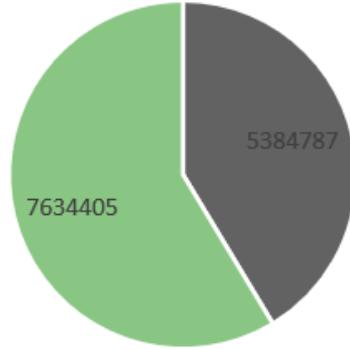


Fig. 3: Cell Coverage Area in Los Angeles County, 10m Taller Towers

■ Not Visible (39%) ■ Visible (61%)

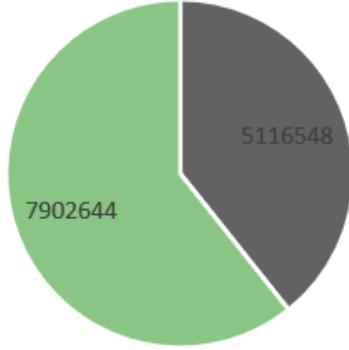
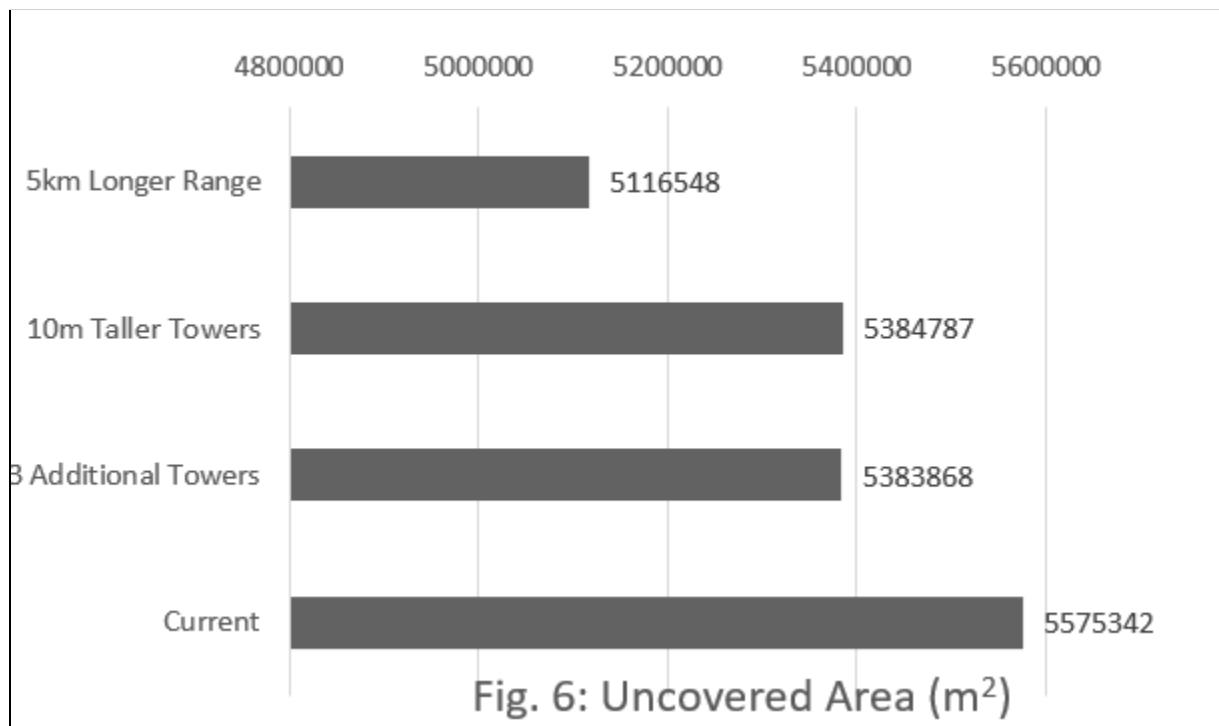
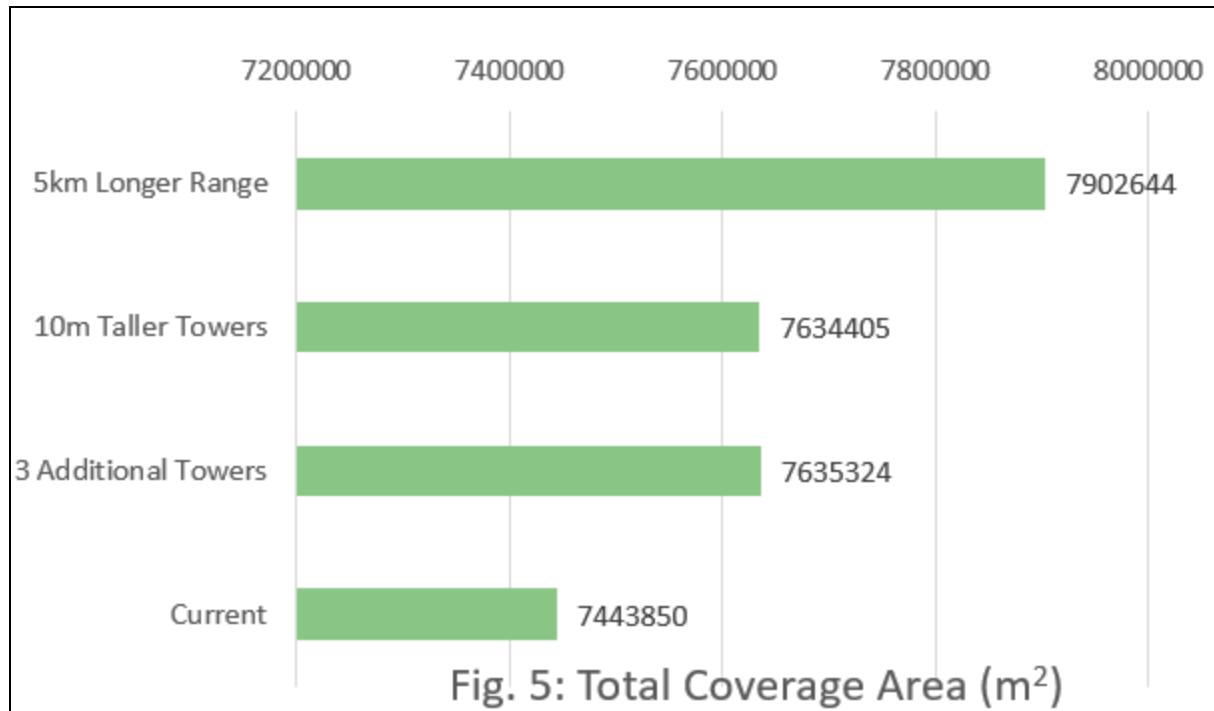


Fig. 4: Cell Coverage Area in Los Angeles County, Tower Range Increased by 5km



Standard Reference

Cell Tower Locations:

https://hifld-geoplatform.opendata.arcgis.com/datasets/0835ba2ed38f494196c14af8407454fb_0/explorer?location=18.425108%2C-15.454722%2C2.83&showTable=true

DEM Raster:

<https://drive.google.com/drive/folders/1ckRIY18Wi1ZAYQ0PclNXsT7UnZ4hbJN5?usp=sharing>

DEM Layer Used: mergedraster1.tif

LA County Shapefile:

<https://drive.google.com/drive/folders/1CdG5rqn5IayNfN4b8J7lb2osM24DjgP4?usp=sharing>