

# Geospatial Investigation of Fort Ord Dunes State Park:

## GIS/GPS Applications

Geography of the Desert Southwest

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### Abstract

The recently developed Fort Ord Dunes State Park north of Monterey, California comprises of an eroding coastal dune complex. The project used several geospatial technologies to better understand both the internal stratigraphy of the dunes and assess the cultural impacts of the abandoned military base. In conjunction with ground penetrating radar (GPR), geospatial tools such as global positioning systems (GPS) and geospatial information systems (GIS) were used. GPS units with varying degrees of resolution mapped the location of the GPR transects and buried ammunition bunkers. Equipment used with increasing accuracy include the Garmin eTrex (<15m), Trimble Juno 3B (3-5m), and real time kinematic Magellan ProMark 3 with base station (1cm). Through ESRI GIS software, collected points and datasets allow the data to be compared with real world variables, such as elevation, slope, and vegetation. ESRI ArcMap assisted with determining accuracy differences between GPS devices (15m to sub-meter resolution) and locating bunker interferences in GPR data. Additionally, ESRI ArcScene enabled placement of publically available satellite imagery over digital elevation models to visualize the topography of the coastal dune complex in 3D. The study provides effective methodology to map and visualize the physical landscape which will aid in future park planning.

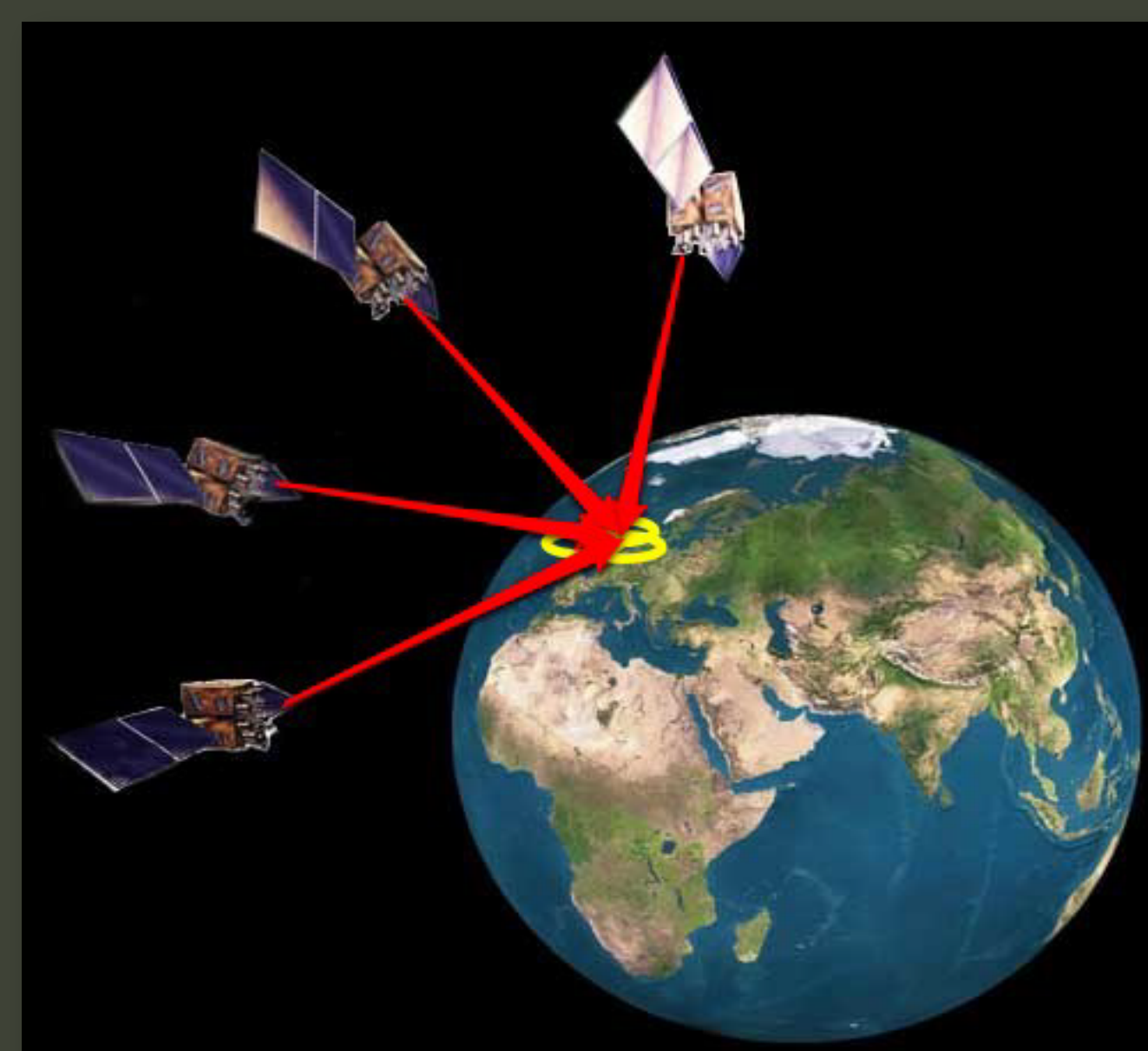
### Background

#### Global Positioning Systems (GPS):

Global Positioning Systems (GPS) are a global navigation system based on more than 24 satellites orbiting the earth. This network provides very precise, worldwide positioning and navigation information. GPS is also known as the NAVSTAR system (NAVigation Satellite Timing and Ranging) and is the official U.S. Government name given to the GPS satellite system.

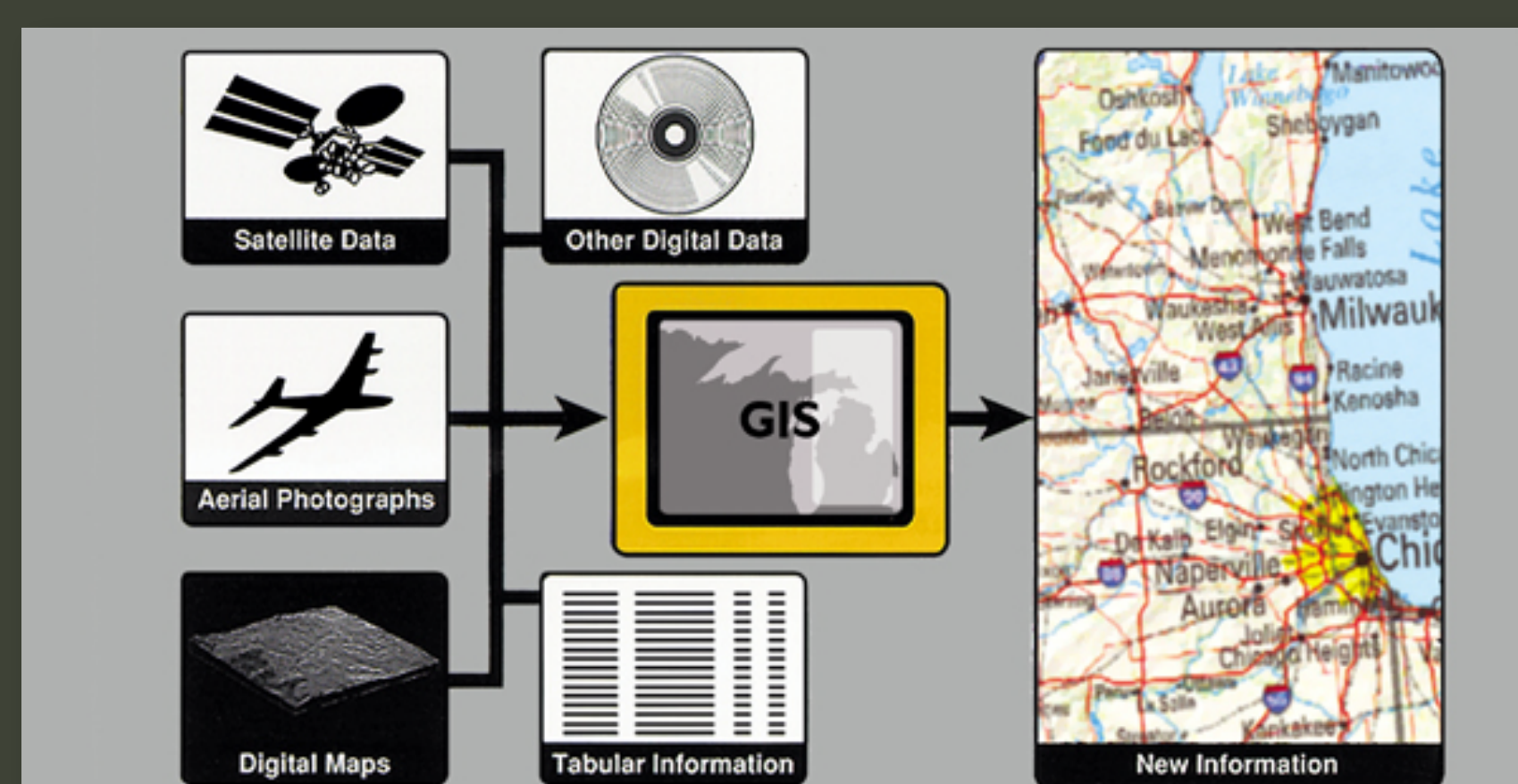
GPS systems function by using a method called triangulation. GPS units calculate the time it takes for a signal to reach a satellite; the time taken determines the distance from the satellite. Once a GPS unit calculates distances of at least three satellites, the unit is able to detect its precise location on the earth. The main factor contributing to the accuracy of a unit is the number of satellites it is able to connect to at one time, with high end units being able to connect to up to twelve satellites.

#### The Process of Triangulation



#### Geographic Information Systems (GIS):

A geographic information system integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of spatially referenced information. GIS allows visualization of data in ways that reveal relationships, patterns, and trends in the form of maps. GIS technology can be integrated into any enterprise information system framework.



### Data Collection:

GPS units recorded subsequent GPR lines throughout Fort Ord State Park. Lines 14, 18, 20, 21, and 22 were recorded using the Magellan ProMark3. Bunker door and vent locations were obtained using Trimble Juno 3B units. Point data were converted into lines, imported into a geodatabase and projected to NAD 1983 California State Plane IV. Data were plotted on a 2012 aerial NAIP photo in order to show context, and ProMark3 and eTrex data were overlain and compared for accuracy.

### GPS Devices Used:

#### Magellan ProMark3:



- Professional Survey/Mapping GPS with Base Station
- RTK system with 1 cm accuracy
- Point, line, and area mapping Accuracy
- Horizontal: 0.005 m + 1 ppm
- Vertical: 0.01 m + 2 ppm
- Observation Time: 4 to 40 minutes

#### Trimble Juno 3B:



- Ruggedized lightweight handheld GPS
- Features 8.9cm touch screen, 5MP camera Accuracy
- Real-time: 2-5m, Postprocessed: 1-3m
- Time to first fix: 30 seconds average

#### Garmin eTrex Legend:



- Small handheld GPS device
- 4 level gray LCD display
- Wide Area Augmentation System (WAAS) Accuracy
- Less than 15m; less than 3m w/ WAAS



### Methods

### Results

#### Garmin eTrex vs Magellan Promark3



The GPS points were integrated into ESRI ArcGIS 10.1 software to create two and three dimensional models of the area. Combining these GPS and GIS datasets with aerial images allows examination of the dunes from an aerial perspective leading to a better understanding of the study area.

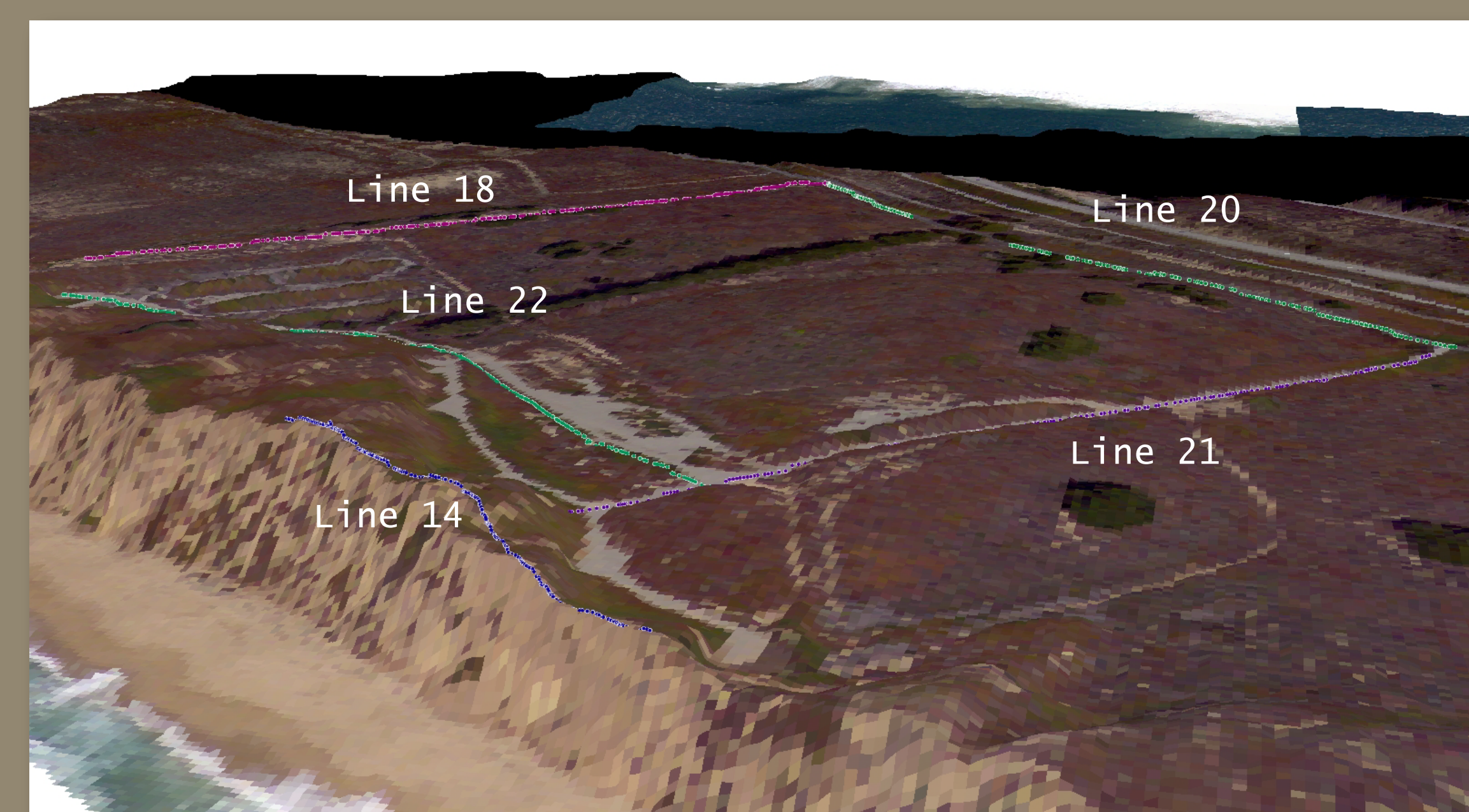
Accuracy issues inherent to GPS include atmospheric errors, multipath errors, and orbital errors. The map to the left shows variability of accuracy with the Magellan ProMark3 and the Garmin eTrex.

#### GPR Lines and Bunker Locations



With the addition of data points collected with the Trimble Juno 3B, we can see the relation between the study area and bunker locations that can be analyzed with adjacent GPR information.

#### Study Area: View from west



Using ESRI ArcScene, GIS datasets can be layered on top of digital elevation models, creating a three-dimensional image. This allows us to gain perspective from an otherwise unreachable vantage point.



The picture above was captured and geotagged with the Trimble Juno 3B. It shows an abandoned military bunker layered with ice plant, an invasive species.

### Conclusions

- GPS unit comparisons show accuracy differences between a professional grade surveying unit and a handheld device.
- GPS data displayed through ESRI Arc software aids in visualizing the topology of study areas.
- Concrete bunkers locations plotted by GPS can help determine the cause of interferences in collected GPR data.
- Overall, GPS and GIS are useful and effective tools for supplementing GPR studies. The geospatial tools used in this study were successfully combined to accurately map the bunkers and should be of use to the Fort Ord Re-Use Authority for planning future park development.

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