Wetlands Correction Factors for LiDAR-based Digital Elevation Models

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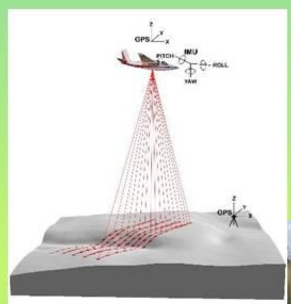
Background

Terrestrial elevation measurement:

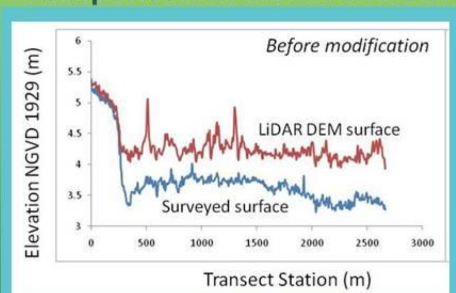


LiDAR: Light Detection And Ranging
--- Spatially extensive, seamless coverage
--- Ease of conversion to DEM
--- Extensive growth and development in the field of LiDAR applications

Traditional Survey
--- Transect based
--- "Gold standard" before RTK - GPS
--- Great value of field notes

Vertical Accuracy	meter
Survey	0.03
LiDAR - CFCA	0.09
LiDAR - USGS	0.045

Comparison of LiDAR and Survey elevation in wetlands:



--- looked at 27 transects along St Johns River (both LiDAR and Survey available)
--- **Consistent bias in herbaceous wetlands – LiDAR always over-predicts ground**
--- Bias in some woody wetland communities

Goals

1) Quantify bias by wetland types

2) Correct DEMs for Water Supply Impact Study of potential effects of surface water withdrawals on wetlands

Photo / graphic credits
LiDAR graphic: http://forsys.cfr.washington.edu/JFSP06/lidar_technology.htm
Wetland photos: Jane Mace, SJRWMD

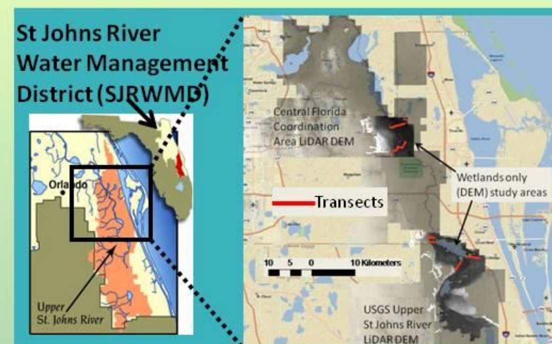
Methods

1) Quantify the bias
2) Classify the bias by wetland types – field survey data
3) Classify the bias by mapped wetland vegetation layer (to be used to correct DEMs)
4) Run statistics for correction model bias
5) Develop correction model – spatially
6) Validate model with independent dataset (transect)
7) Correct DEMs

Study area (DEMs)

Two LiDAR-derived DEMs along St Johns River.

The DEMs were clipped to wetland areas only.



Survey specifications

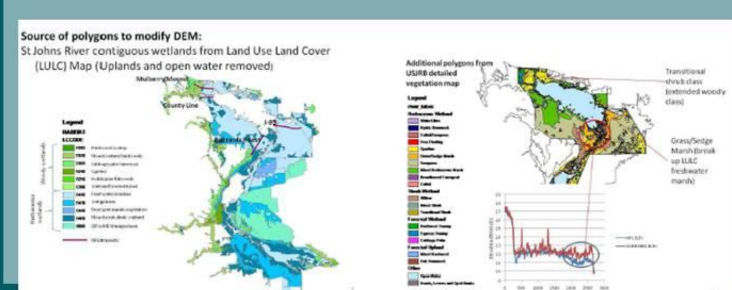
SJRWMD Minimum Flows and Levels (MFL) Program Appendix E-6 – Field Sampling Procedures, Minimum Flows and Levels Manual, SJRWMD (draft)

LiDAR specifications

Baseline Specifications for Orthophotography and LiDAR v 1.2, Florida Department of Emergency Management (2007)

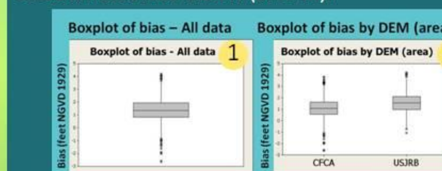
Vegetation data for correcting DEM

- Wetland classification systems abound
- Field-based (transect, linear; most detailed) but impossible to translate spatially; "snapshot" in time
- GIS (remote sensing / photo interpretation), spatially extensive , not nearly as much detail; "snapshot" in time

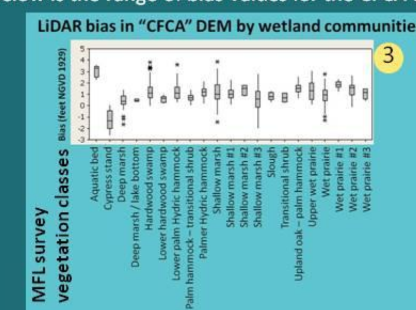


Wetland Bias

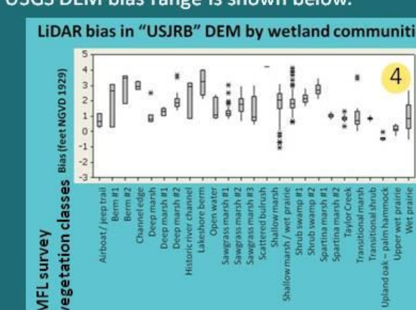
The mean LiDAR bias for all 1,888 points (both DEMs) was 1.36 ft (0.42 m). The mean for the CFCA dataset was 1.09 ft (0.33 m) and for the USGS dataset was 1.54 ft (0.47 m).



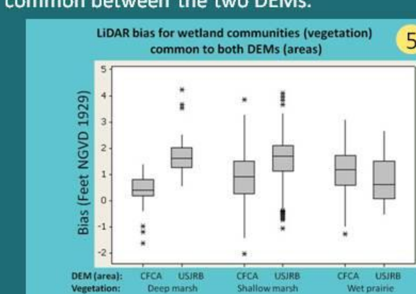
Below is the range of bias values for the CFCA DEM.



USGS DEM bias range is shown below.



There were only three vegetation classes in common between the two DEMs.



Results & Conclusions

Goal 1 – Quantify bias by wetland type

Two Way ANOVA results:

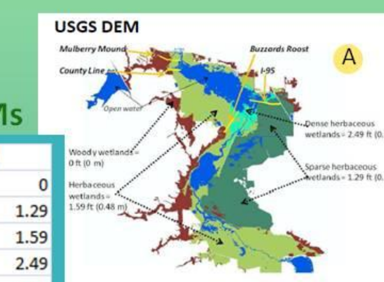
- The overall difference in LiDAR bias between the CFCA and USJRB DEMs is not significant (box plot #2)
- The difference in LiDAR bias due to vegetation types between CFCA and USJRB is significant (box plot #5).

Conclusion Goal 1 – Patterns of bias by wetland type exist but are not consistent between DEMs (areas) thus necessitating area specific correction for wetland bias.

Goal 2 – Correct DEMs

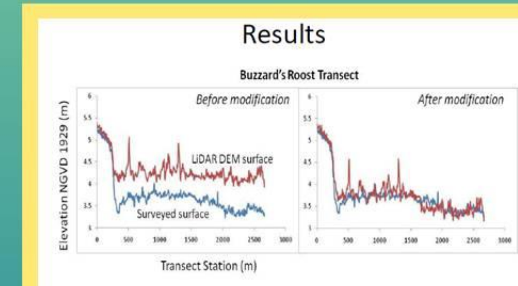
Develop correction factors for DEMs

DEM	Wetland Veg type	correction (m)	(ft)
USGS	Woody	0	0
	"Sparse" herbaceous	0.39	1.29
	Herbaceous	0.48	1.59
	"Dense" herbaceous	0.76	2.49
CFCA	All types	0.33	1.09



DEM Correction

The USGS DEM was corrected using a polygon dataset (A). Only one correction factor could be justified for the CFCA DEM. The correction model was validated using an independent transect.



Post Correction Error

Balanced error (median = 0) in final DEM indicates that over corrections balance under corrections.

DEM	Median Error - post correction (m)
USGS	0
USGS, validation transect	0.012
CFCA	-0.03

Conclusions Goal 2 –

- **The final study DEMs were greatly improved by correction process.**
- **This DEM correction process is heavily dependent upon vegetation polygons.**

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References: Mace, M. J. (2007a). Minimum levels determination: Lake Poinsett in Brevard, Orange, and Osceola counties. Draft Report. St. Johns River Water Management District, Palatka,FL
USGS DEM: Dewberry (2010) Project Report for the USGS St Johns Water Management District – ARRA LiDAR
CFCA DEM: Dewberry (2010) Specific Purpose LiDAR Survey Report for the 2010 Central Florida Coordination Area Surface Elevation Dataset

LiDAR Image credit – http://forsys.cfr.washington.edu/JFSP06/lidar_technology.htm