Gully Evolution in Agricultural Fields Using Ground-Based LiDAR

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Introduction

- In agricultural fields, gully erosion can be significant and often comparable to or exceeding sheet and rill erosion

- Many modeling tools have been developed to estimate sediment transport from sheet and rill erosion sources

- Recently, sediment erosion from gully sources are receiving more attention from the scientific community

Introduction

- Ephemeral gullies can be a significant source of sediment

Introduction (continued)

Annualized Agricultural Non-Point Source (AnnAGNPS) pollution model

- **A partnering research effort between the USDA-Agricultural Research Service (ARS) and Natural Resources Conservation Service (NRCS) to evaluate the effect of non-point source pollutant loadings within agricultural watersheds.**
- **Evaluate existing and alternative agricultural practices to assess and reduce their impact on the environment.**
- **Simulates runoff, sediment, nutrient and pesticide contributions from agricultural fields to streams routing daily flow through the watershed.**

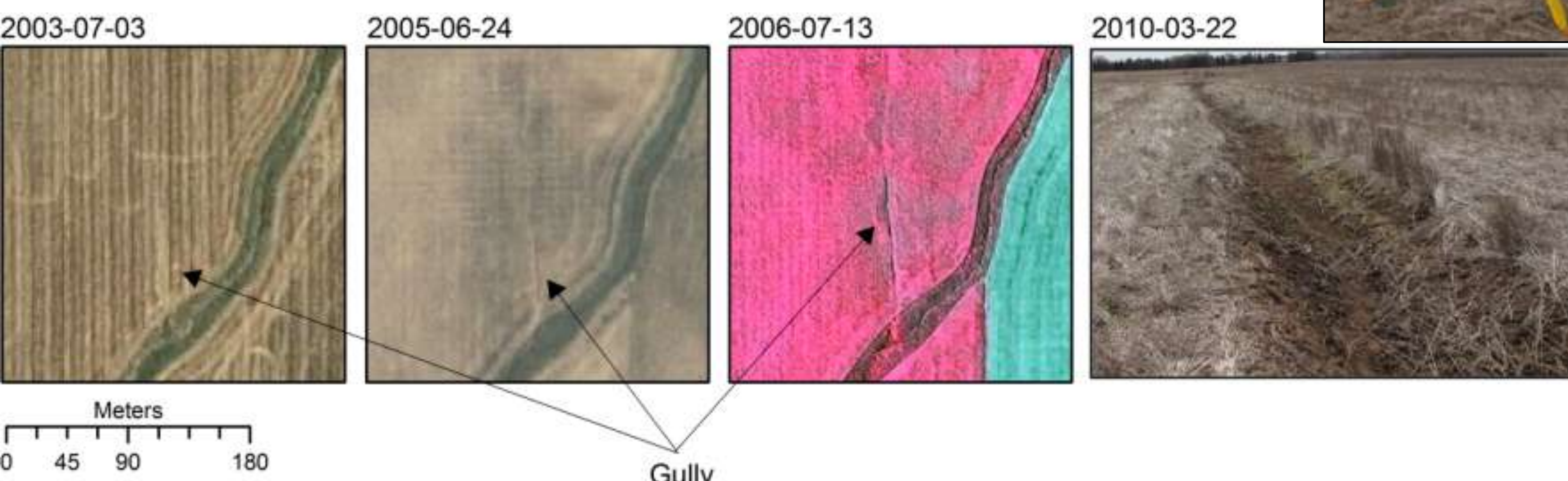
Introduction (continued)

AnnAGNPS enhanced with gully components

- AnnAGNPS gully component uses information from databases containing:
    - Topography
    - Soil characteristics
    - Long term climate records
    - Land management at individual field scale
- AnnAGNPS uses this information to determine gully evolution in terms of channel:
    - **widening**,
    - **incision**, and
    - **head cut migration rate**
    - **conservation management**

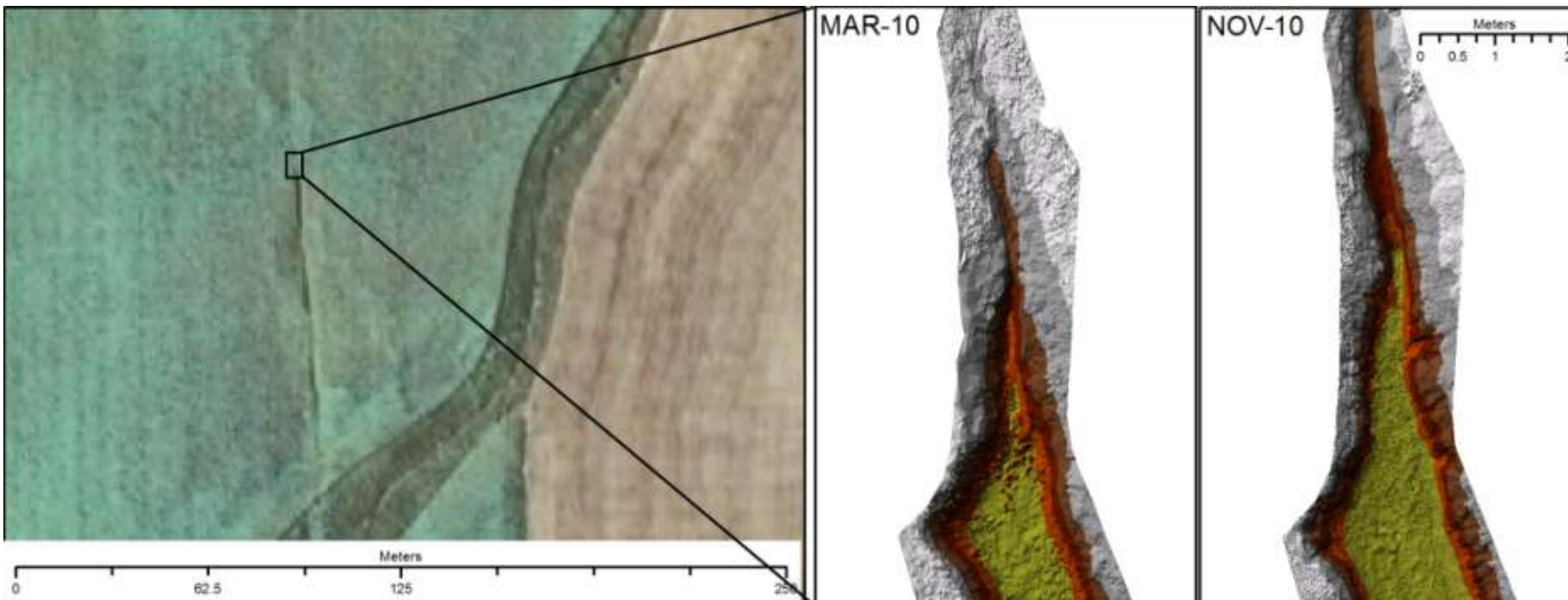
Introduction (continued)

- Quantitatively and systematically monitor small-scale gully evolution located in agricultural croplands
- Ground-based LiDAR survey as a basis for validation of AnnAGNPS gully components:
  - Widening
  - Incision
  - Head-cut migration
  - Land management at an individual field scale



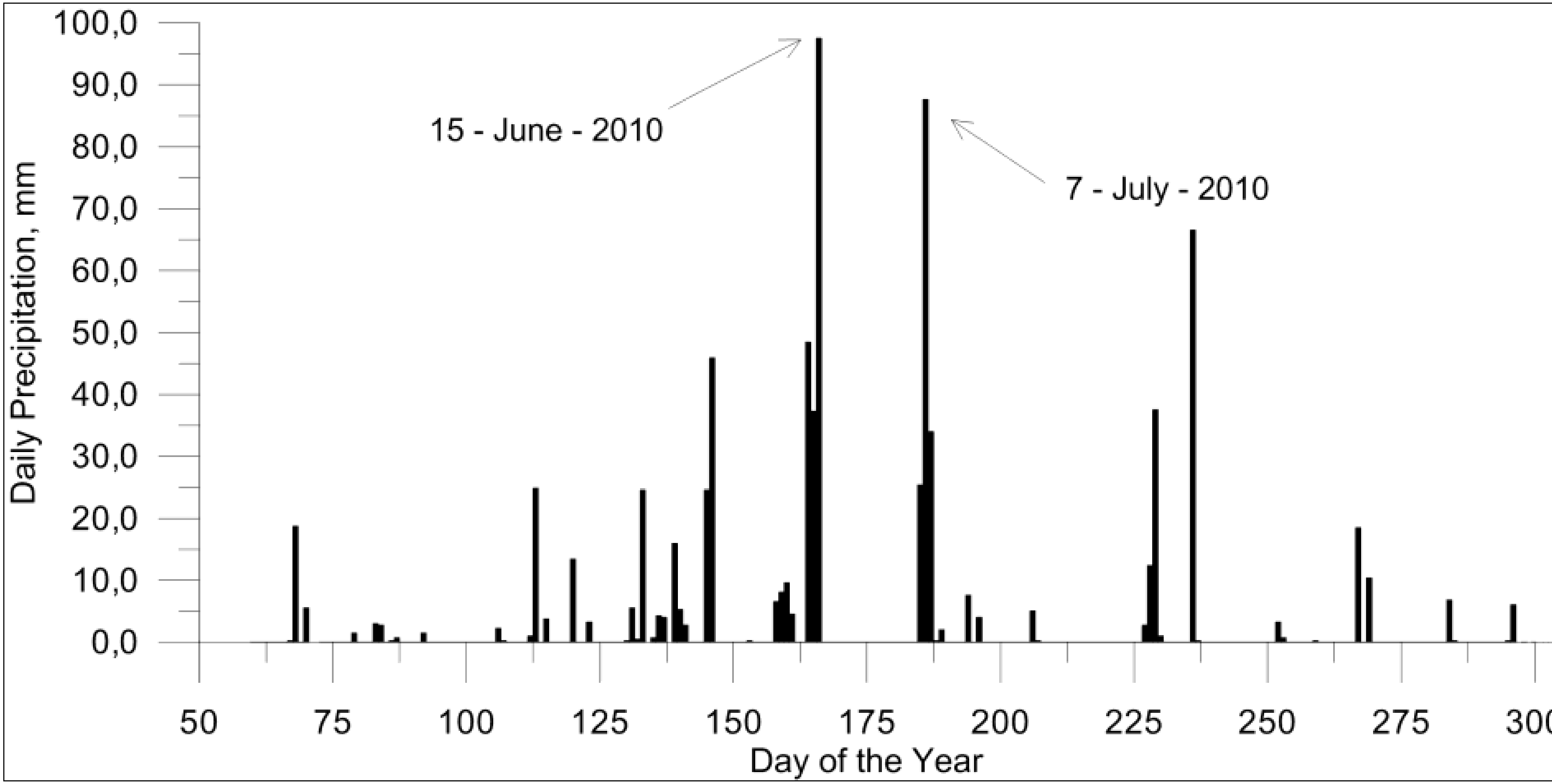
Methodology

- Cheney Lake Watershed, South-Central Kansas site visited in
  - March 2010 (~ 1 million points measured) and
  - November of 2010 (~ 4 millions points measured)
- TOPCON GLS-1000 - 2 mm single point accuracy distance
- No-till field, crop rotation was wheat followed by sorghum (milo)



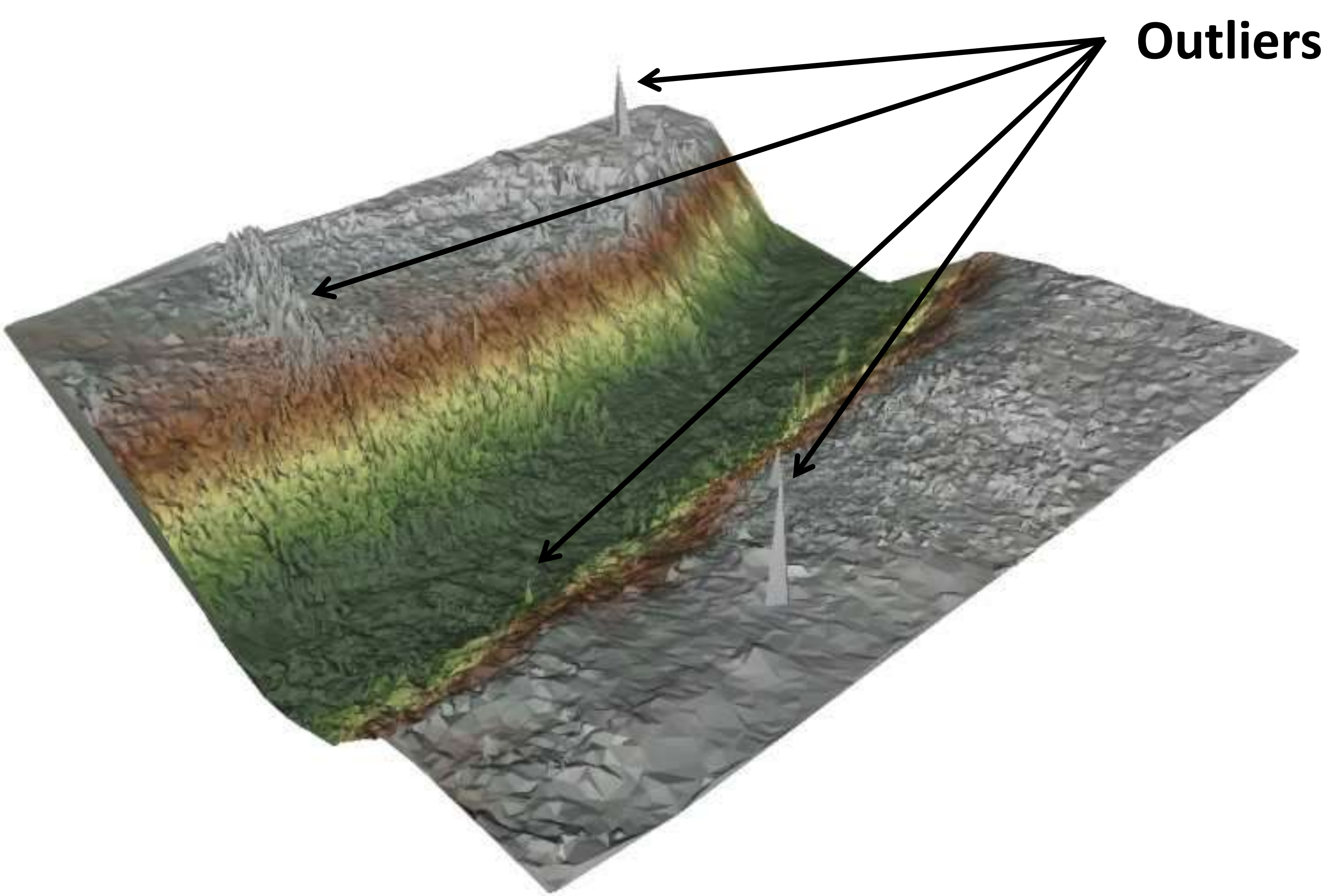
Methodology (continued)

- Two major precipitation events between March and November



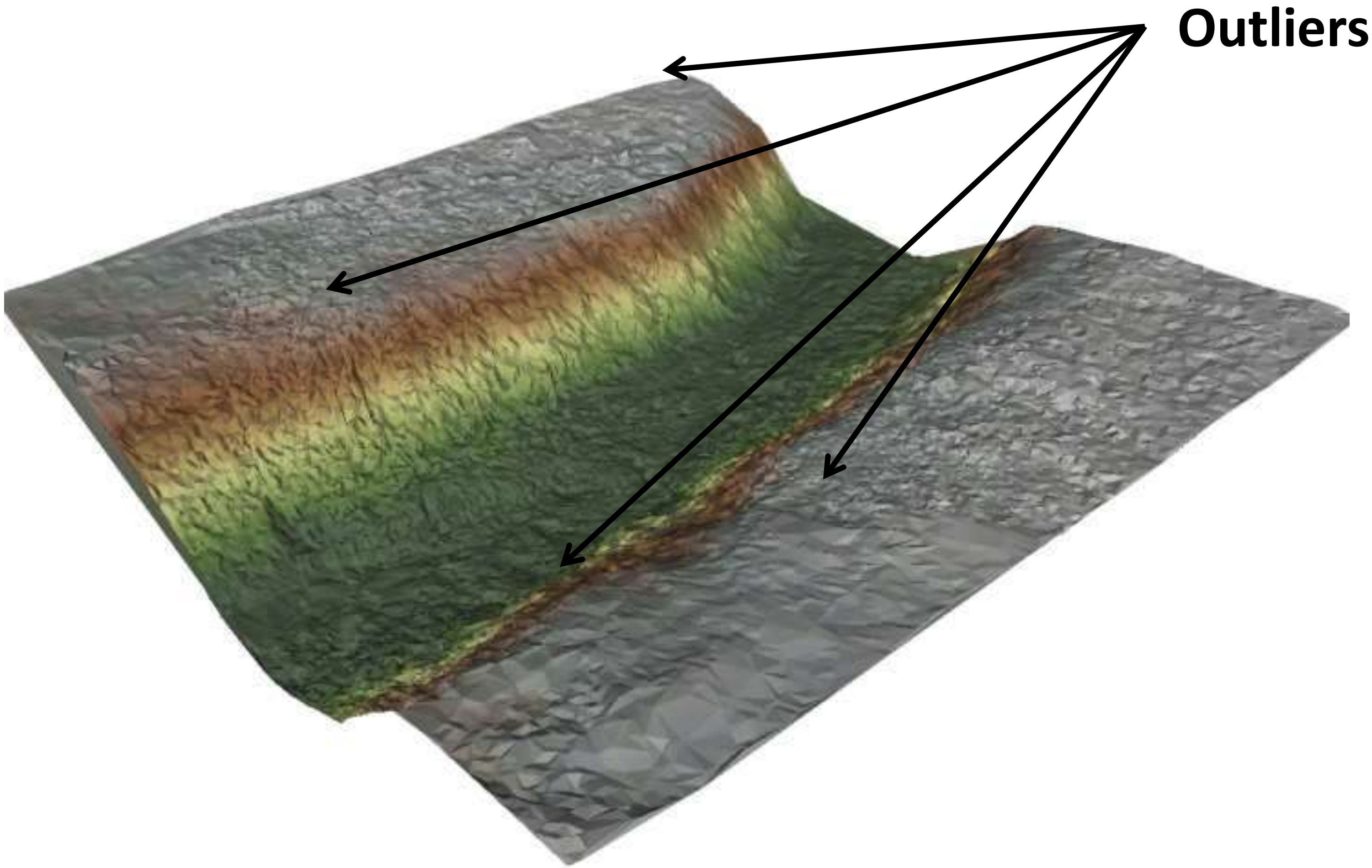
Methodology (continued)

- Data processing: outlier removal



Methodology (continued)

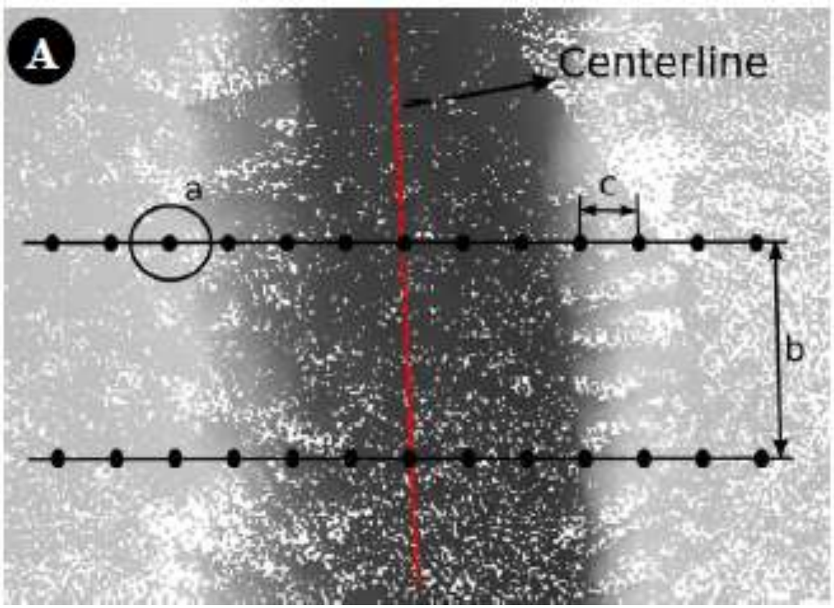
- Data processing: outlier removal

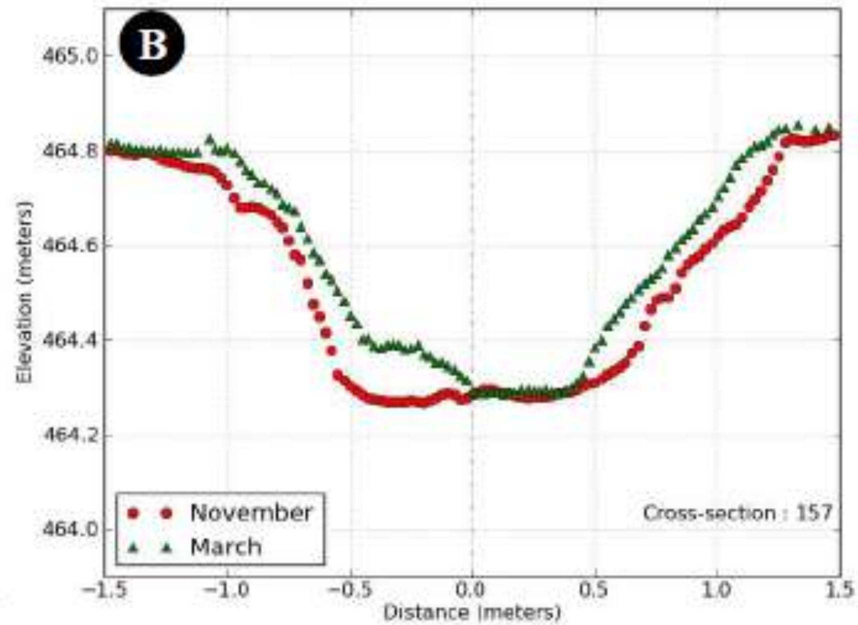


(k= 100, polynomial degree = 1, and threshold = 1cm)

Methodology (continued)

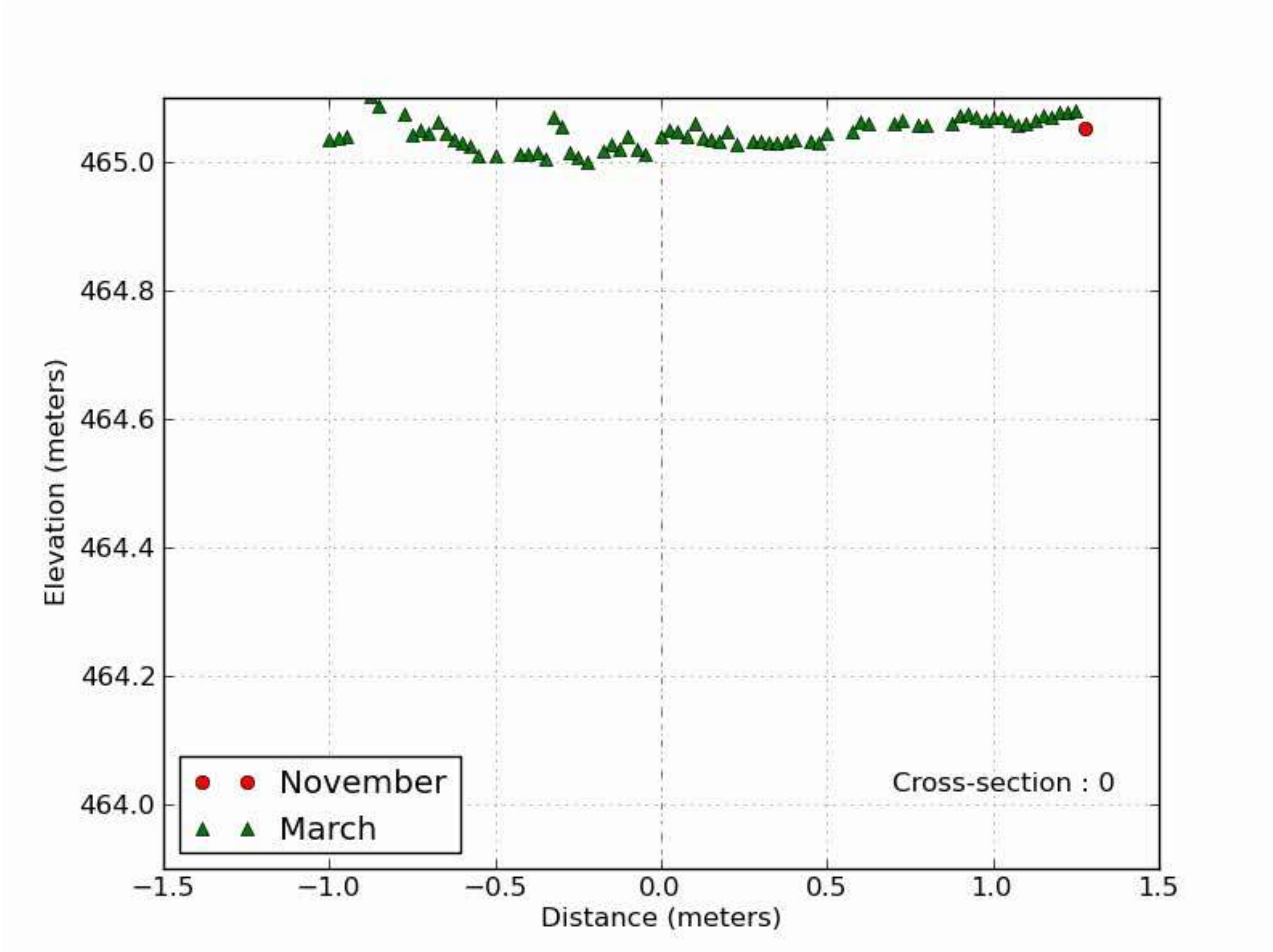
- **Data processing: Automated cross-section generation**





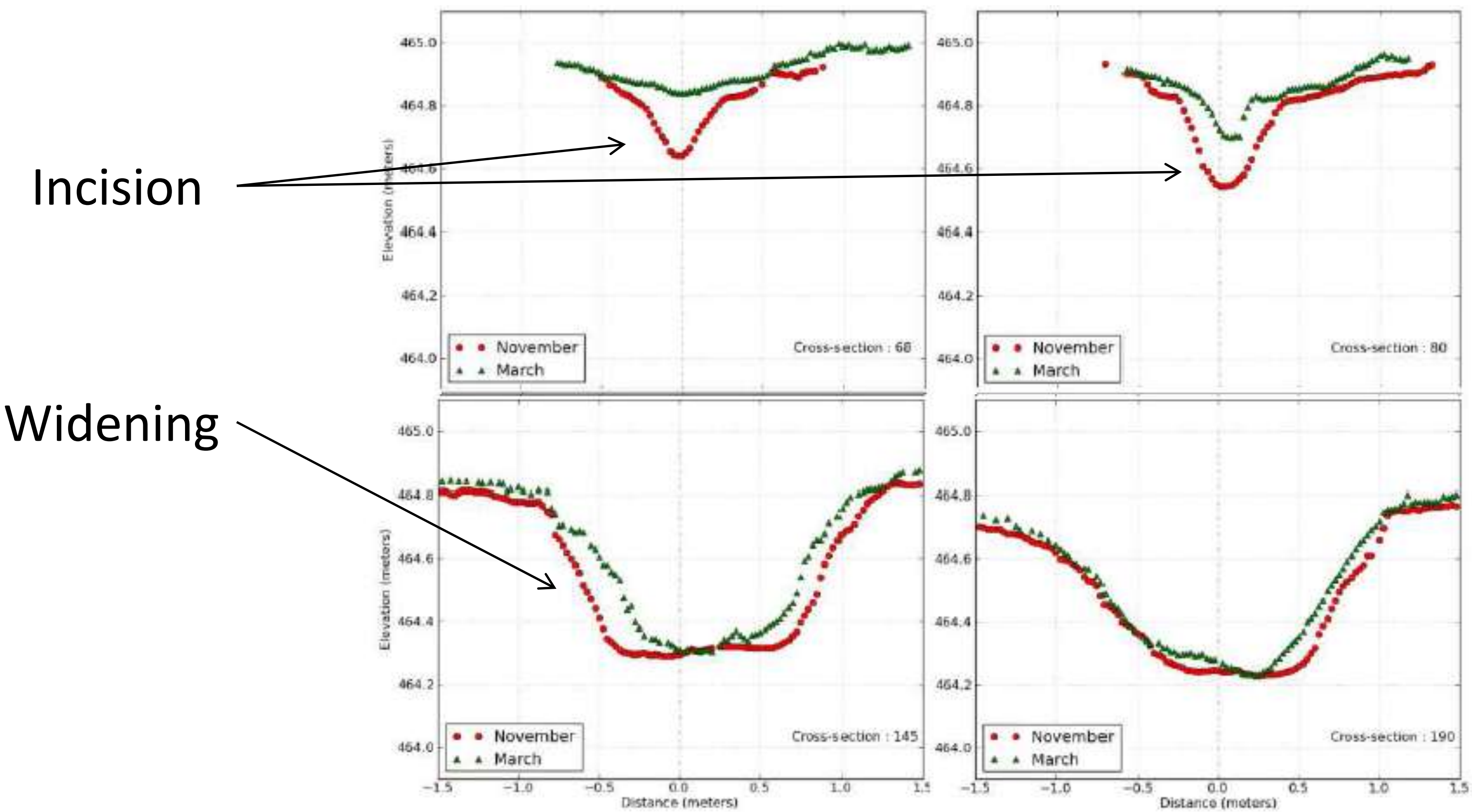
Methodology (continued)

- Data processing: Automated cross-section generation



Methodology (continued)

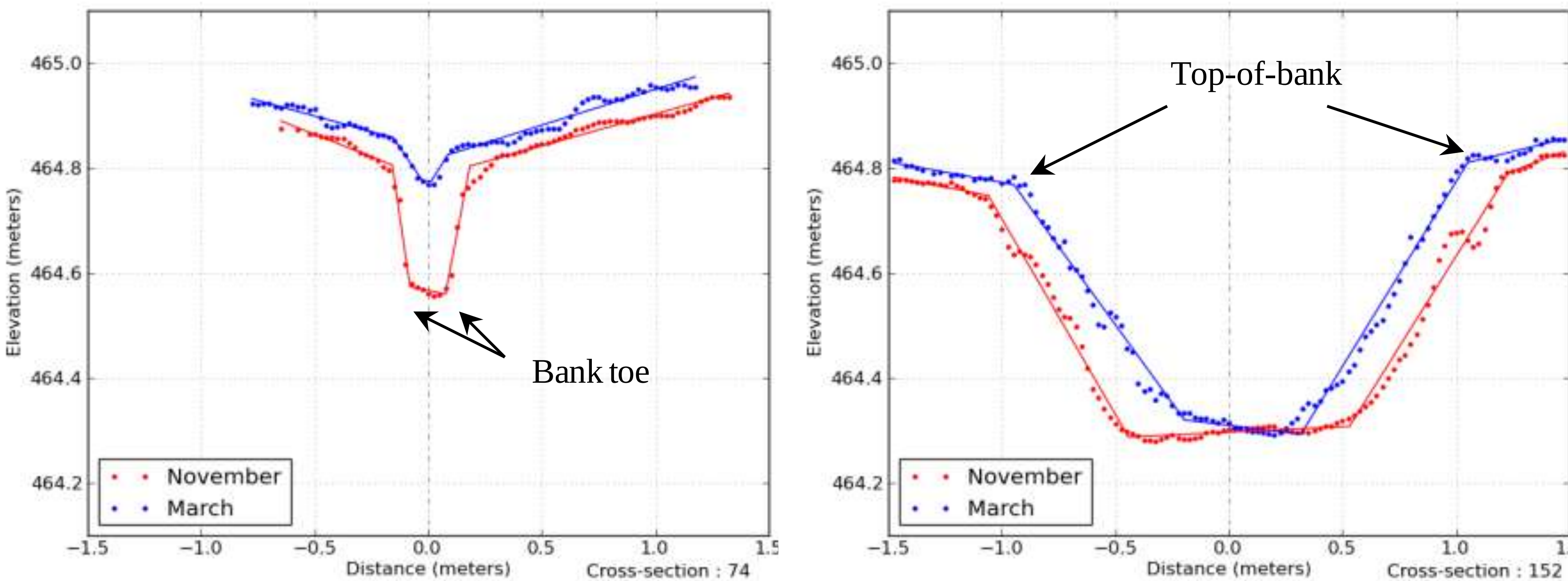
- **Data processing: Automated cross-section generation**



Total of 405 cross-sections per survey

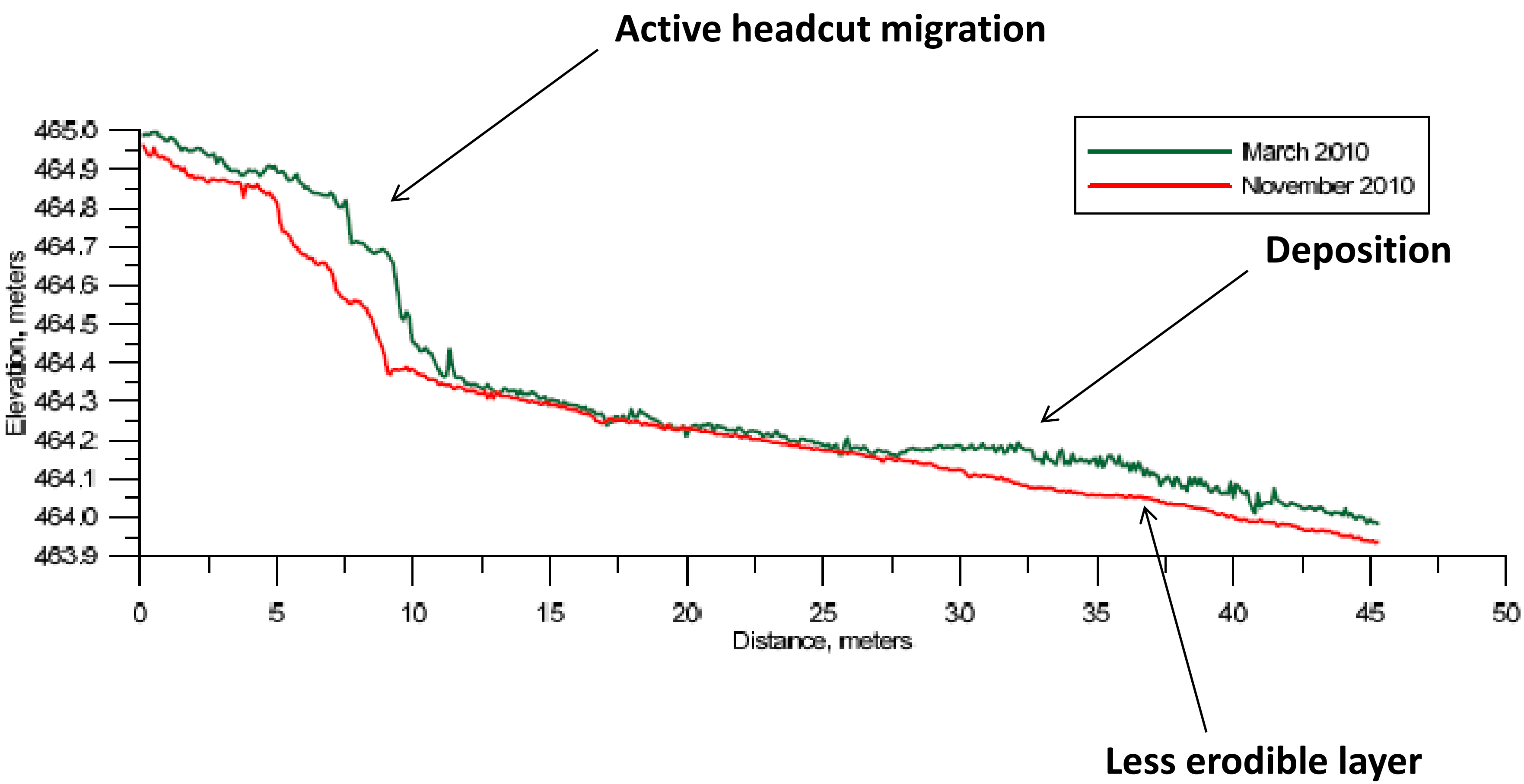
Methodology (continued)

- **Data processing: Automated trapezoidal cross-section fitting**



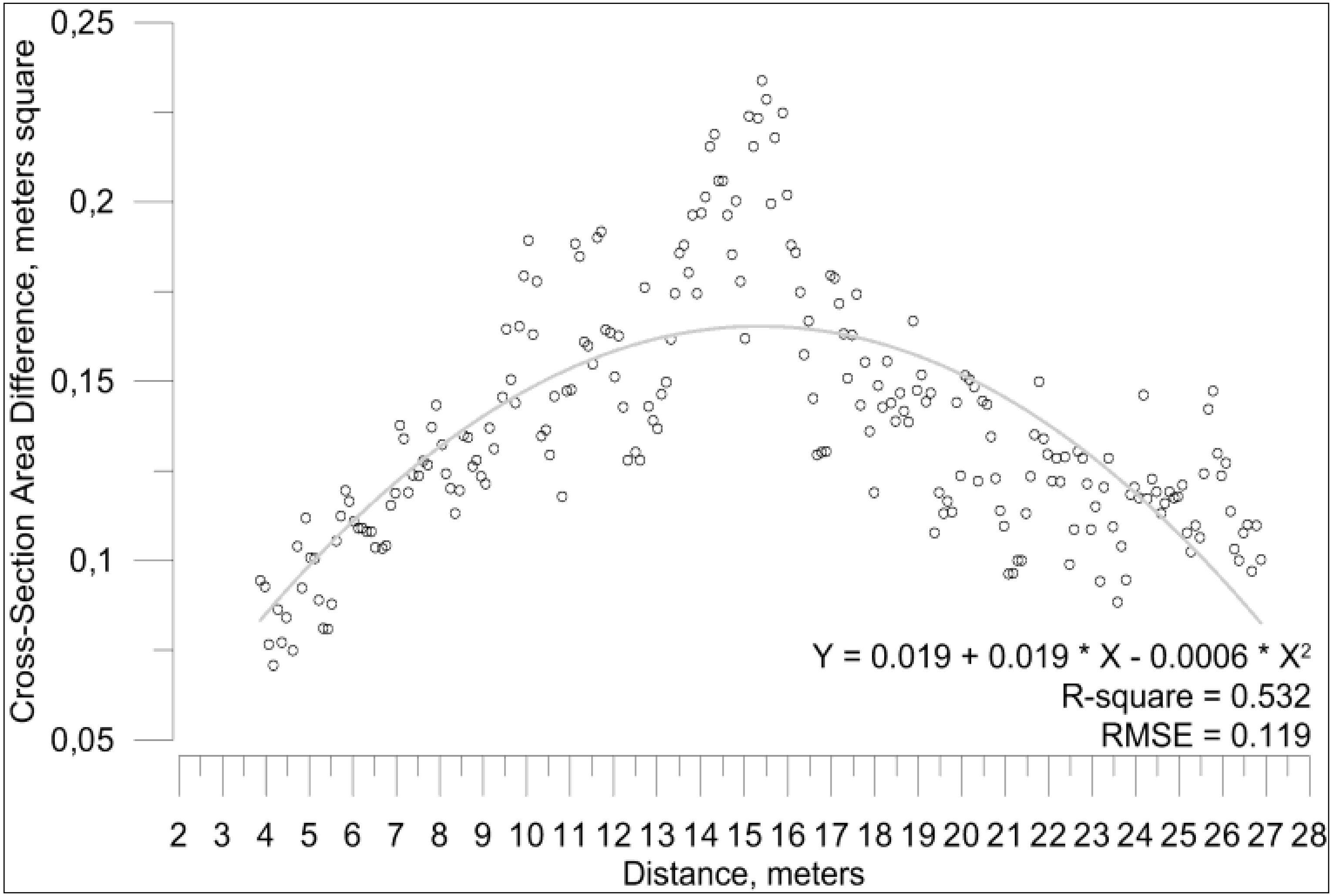
Methodology (continued)

- Data processing: Automated thalweg generation



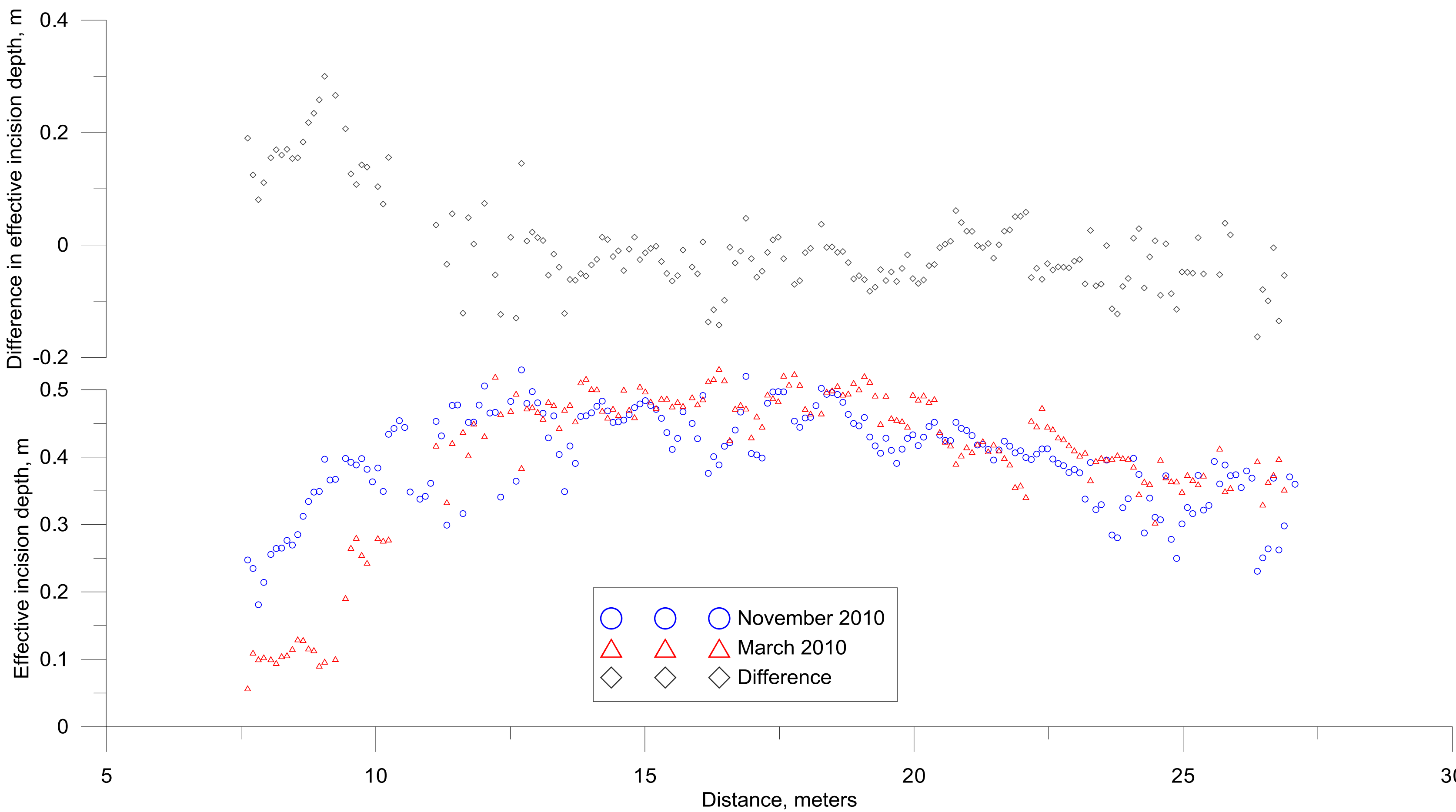
Results

- Percentage change in cross-section area between surveys



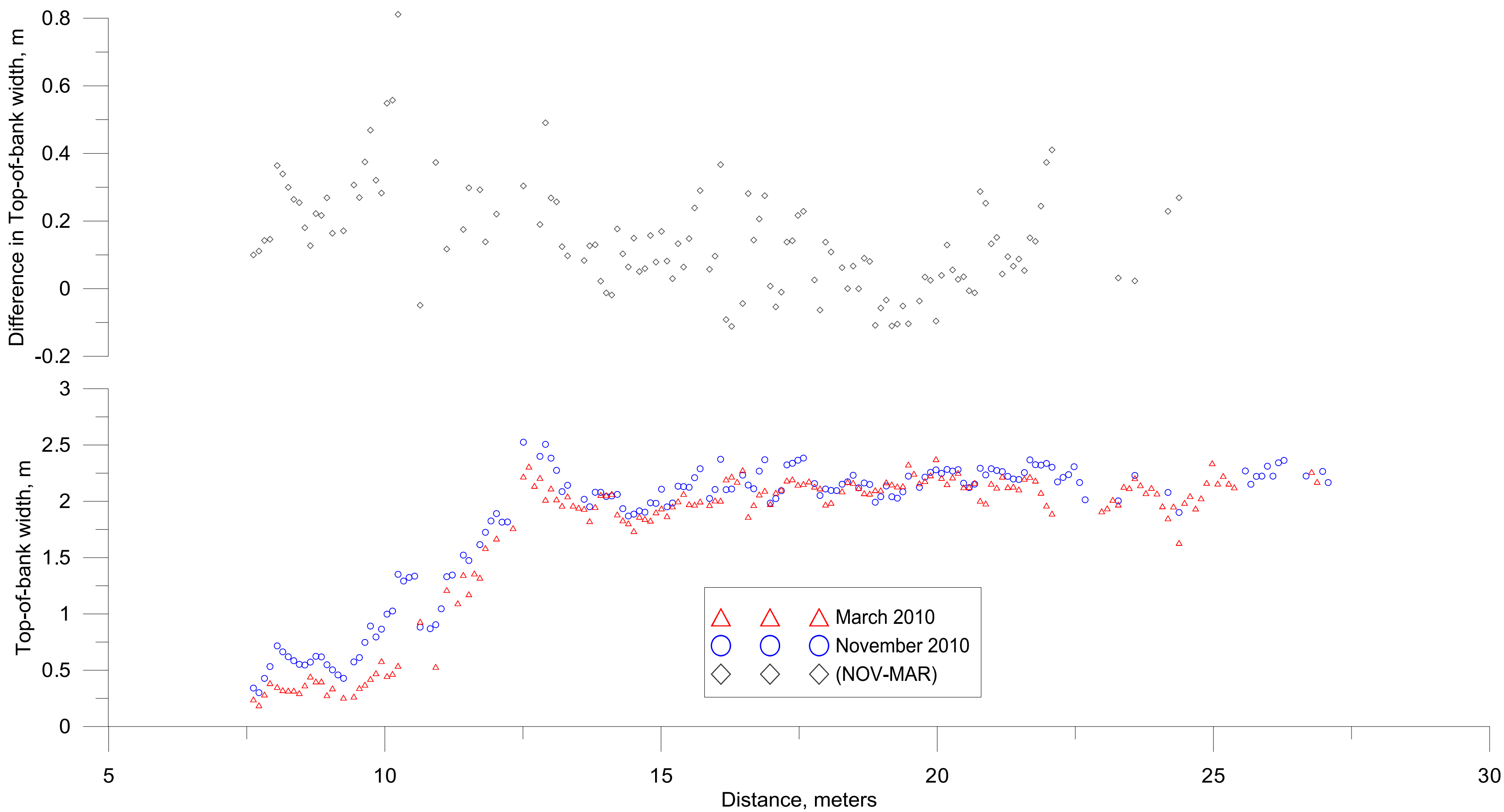
Results (continued)

- Effective incision changes between March and November



Results (continued)

Top-of-bank changes between March and November



Conclusions

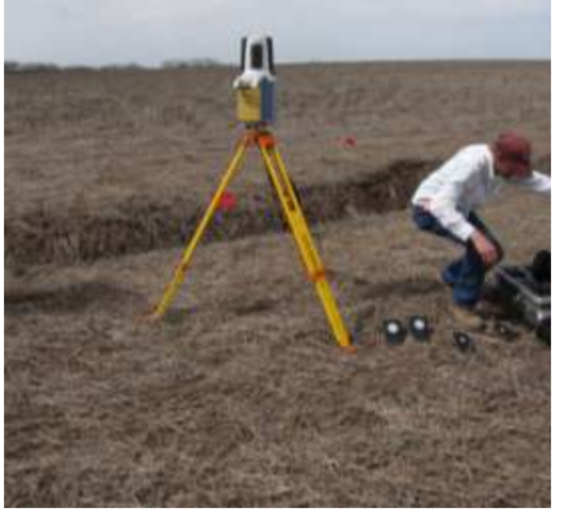
- The utilization of new technologies, such as ground-based LiDAR, provides capabilities to develop new tools for the scientific investigation of physical processes responsible for gully formation and evolution

- Long-term monitoring of gullies in agricultural fields used in conjunction with laboratory work provides valuable information for experimental design and theory validation that can then be incorporated into modeling tools (AnnAGNPS)

- Future studies will include the selection and monitoring of multiple study sites at different geographical locations with varying environmental and physical conditions to cover a wide range of variables influencing gully formation and evolution.

Acknowledgements

- Lisa French and Howard Miller, at Cheney Lake Watershed, Inc.
- Lyle Frees at USDA-NRCS for contacting and coordinating with local land owners and for providing vital logistic support
- Thanks are also due to Don Seale and Antonia Smith for their indispensible assistance during data collection



Questions