Quantifying Relationships Between Point Bar Geometry and Channel Dimensions in the Ping River, Chiang Mai

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Research Summary

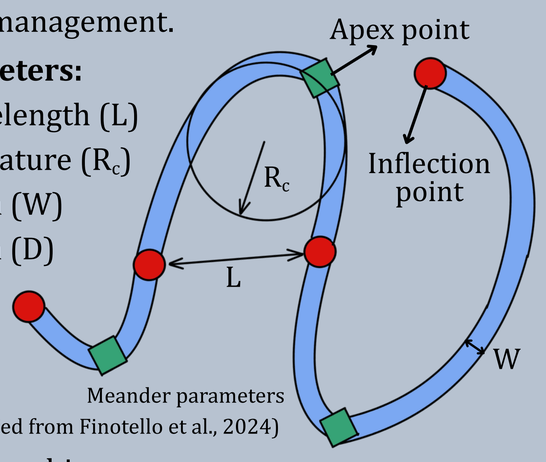
- This study quantified channel and bend geometry relationships in the Ping River, Chiang Mai, Thailand.
- Measurements were derived from Google Earth Pro imagery and RID water gauge data.
- 246 bends were digitized, 81 bends retained after filtering disturbed or complex sections.
- Power regression was used to evaluate relationships between variables.
- Strong correlations between channel size and bend geometry were observed, suggesting that the Ping River follows predictable patterns and can serve as a modern analogue for ancient fluvial systems.

Introduction

- Meandering rivers develop distinct geometric patterns related to channel sizes.
- Understanding these patterns helps improve predictions of fluvial deposit geometry and future water management.

Measured parameters:

- Meander wavelength (L)
- Radius of curvature (R_c)
- Channel width (W)
- Channel depth (D)
- Sinuosity



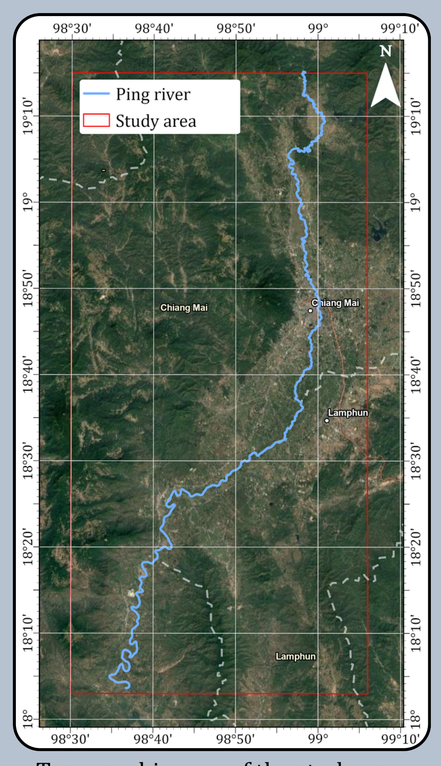
Meander parameters (modified from Finotello et al., 2024)

Ocjectives

- Quantify relationships between channel dimensions and meander geometry in the Ping River.
- Evaluate whether these relationships are predictable.

Study Area

- Ping River, Chiang Mai, Thailand
- Study reach extends from Mae Taeng to Doi Tao.
- The river exhibits well-developed bend morphology and point bars.

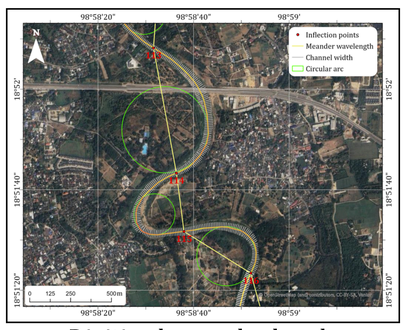


Topographic map of the study area

Methods

Data Collection

- Google Earth Pro satellite imagery (April 19, 2023)
- Hydrological data: RID gauge stations
- Digitize channel using Google Earth Pro & ArcGIS Pro



Digitized meander bends

Bend Identification

- Detect inflection points and calculate meander bend sinuosity using MStat
- Total bends identified: 246

MSTAT Meander Statistics Toolbox

Bend Selection
Sinuosity > 1.2

No → Exclude from dataset

110 bends used → Yes

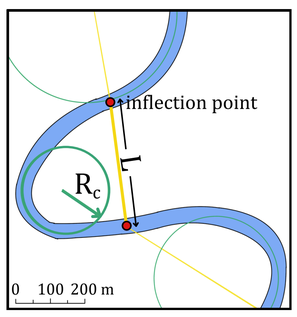
Bend Filtering

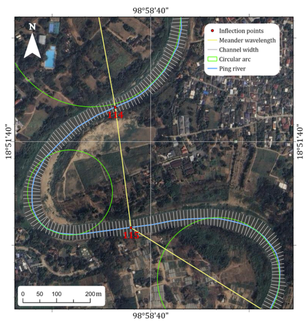
- Remove bends affected by:
  - Human disturbance (dam , bank modification)
  - Multiple small bends in one loop
  - Mountainous reaches

81 bends used

Parameter Measurement

- Measure using Google Earth Pro & ArcGIS
  - Channel width (W)
  - Radius of curvature (R_c)
  - Meander wavelength (L)





Data Analysis

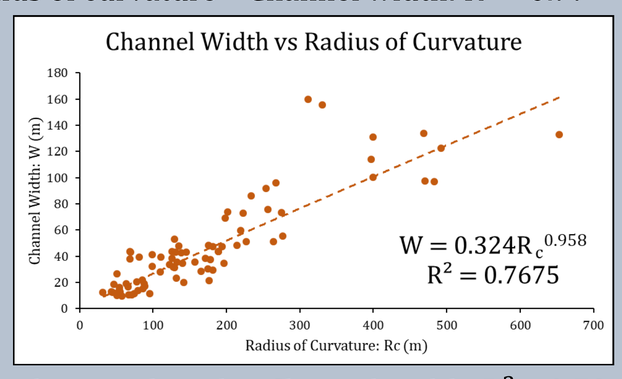
- Export data to Microsoft Excel
- Perform power-law regression analysis
- Evaluate relationships using R^2 values

Results

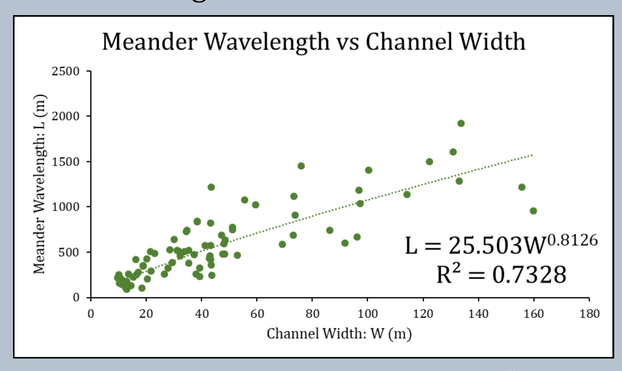
- Analysis of 81 meander bends shows strong relationships between channel and bend geometry.

Key correlations:

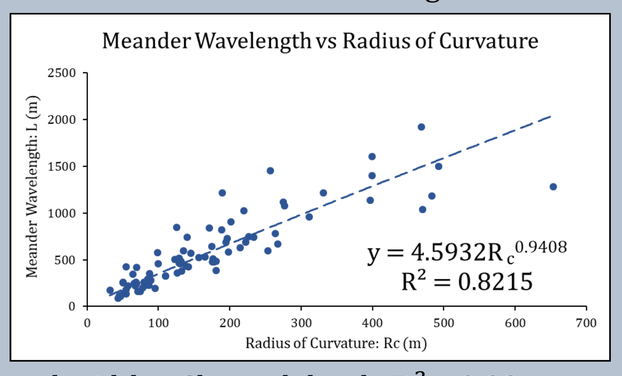
- Radius of curvature – Channel width: $R^2 = 0.77$



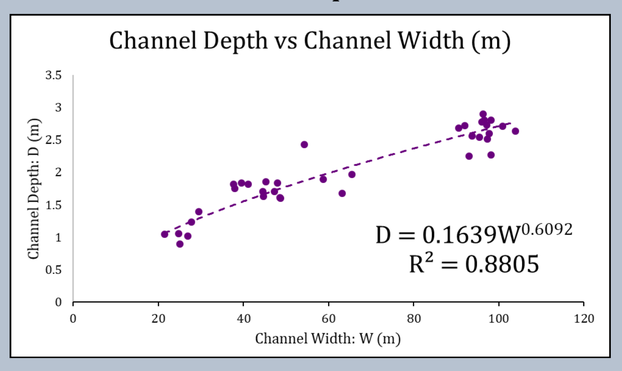
- Meander wavelength – Channel width: $R^2 = 0.73$



- Radius of curvature – Half wavelength: $R^2 = 0.82$



- Channel width – Channel depth: $R^2 = 0.88$



Key observations:

- Channel width and depth show the strongest correlation.
- Meander geometry parameters show consistent scaling relationships.
- Relationships follow typical power-law behavior observed in meandering rivers.

Discussion

- Strong correlations indicate that Ping River geometry follows predictable scaling relationships.
- Relationships between width, curvature, and wavelength reflect flow dynamics and sediment transport processes.
- The strong correlation between Rc and wavelength ($R^2 = 0.81$) indicates organized meander development.
- These relationships suggest that meander geometry can be predicted from basic channel dimensions.
- The Ping River displays characteristics typical of alluvial meandering rivers.

Study Applications

- Providing modern analog data for interpreting fluvial deposits where subsurface seismic resolution is limited.
- Supporting river management and geomorphology studies using data from the Ping River.

Conclusions

- This study quantified relationships between channel size and meander geometry in the Ping River.
- Analysis of 81 meander bends revealed strong power-law relationships between measured parameters.
- The strongest relationship was observed between channel width and depth ($R^2 = 0.88$).
- Meander geometry parameters also showed strong correlations with channel width and wavelength.
- Results demonstrate predictable scaling relationships in meandering river systems.
- The Ping River can serve as a modern analogue for studying fluvial sedimentary systems.
- Findings contribute to improved understanding of fluvial geomorphology and reservoir geometry prediction.

References

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