Investigating the morphotectonic evolution of Chiayi-Tainan area based on geomorphometry and fluvial terraces

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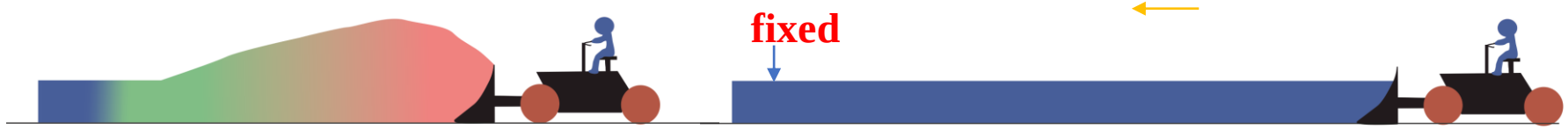
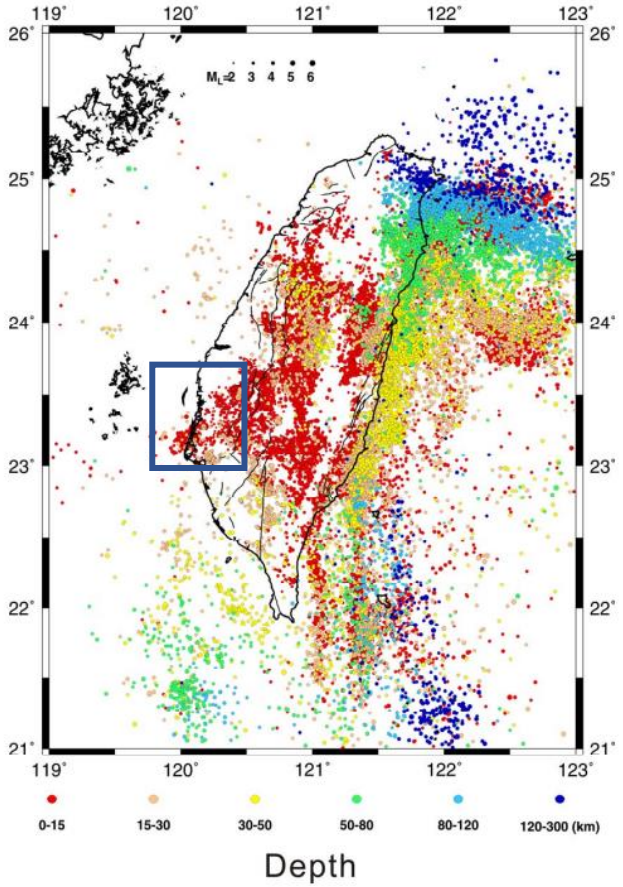
Date: 2022/11/11

Outline

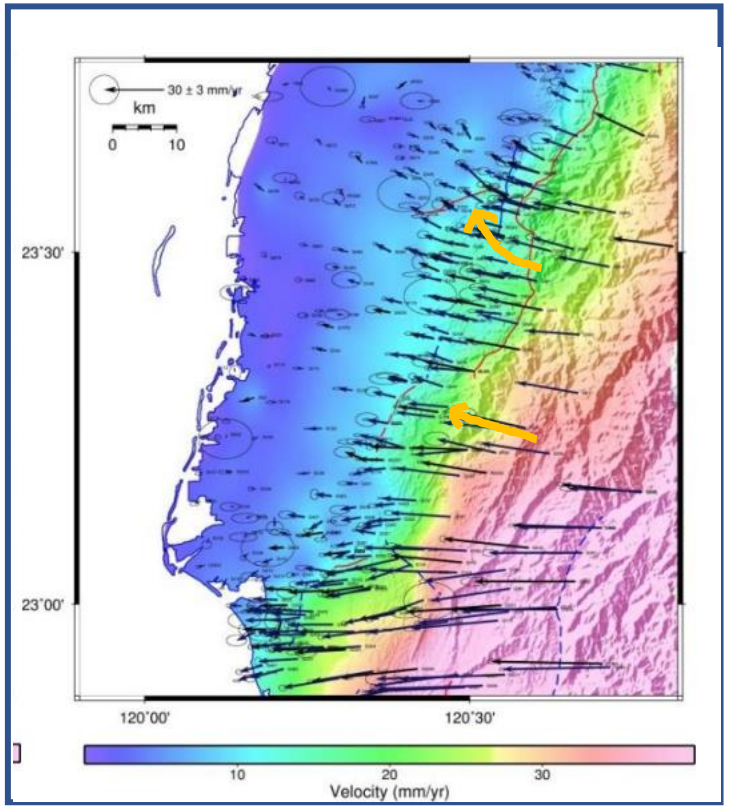
1. Introduction
   - Motivation
   - Geological setting
   - Purpose
2. Basic concept
3. Methodology
4. Preliminary result
5. Future work

Introduction

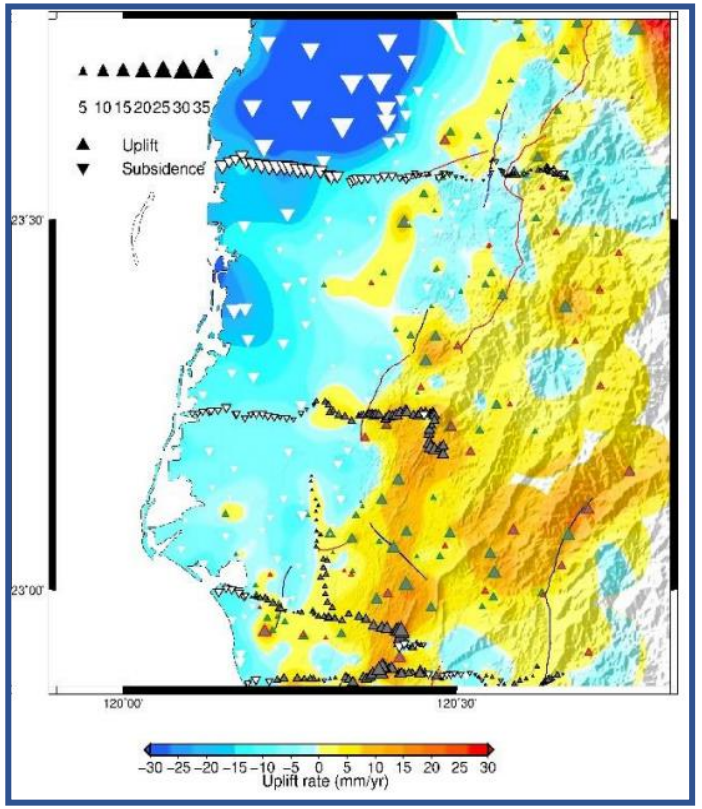




1990-2006 Seismic activity distribution from CWB (Huang, 2009)



The horizontal velocity field



The vertical velocity field

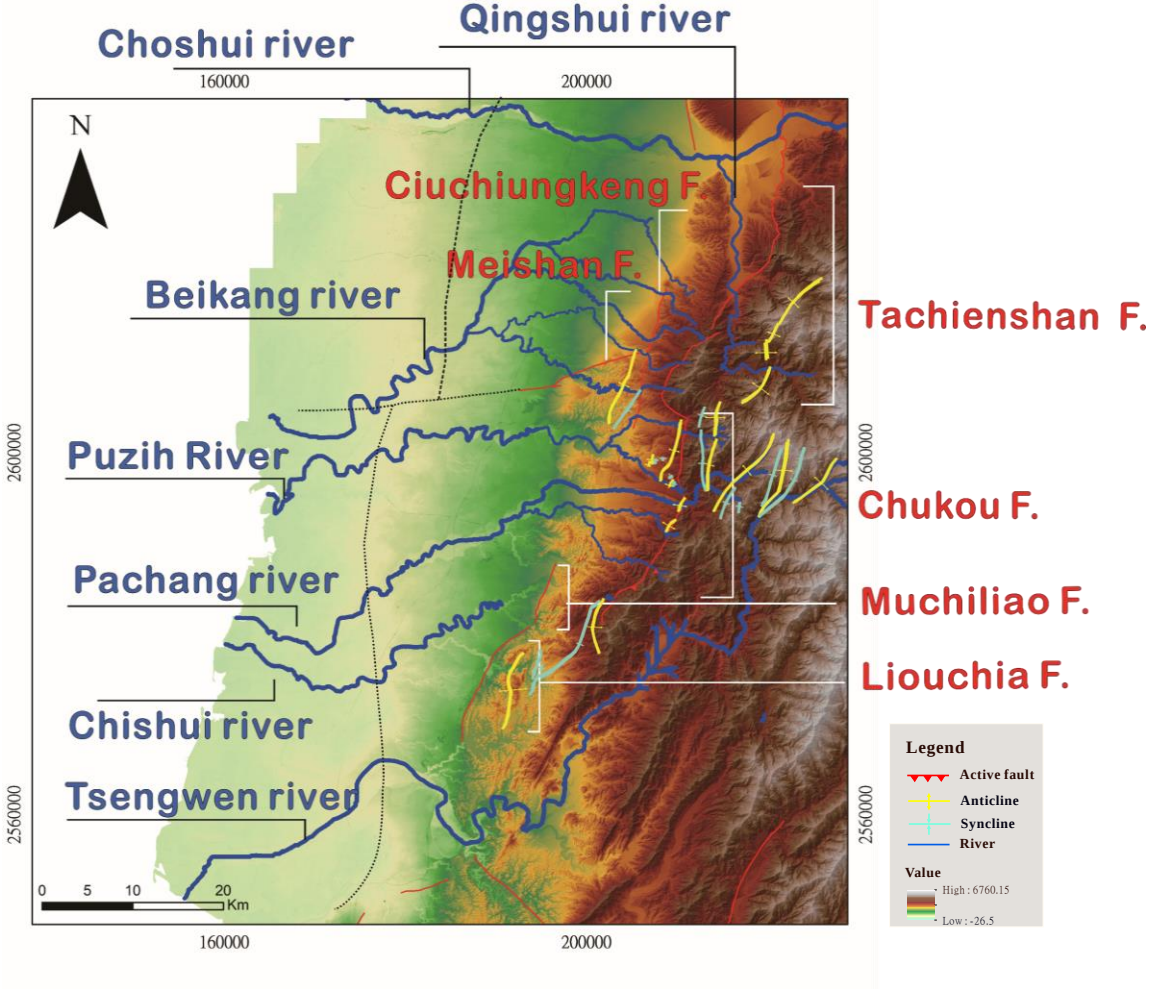
2010-2017 Geodetic Observations in south-western Taiwan (Ching et al., 2018)

Motivation from geodetic data :

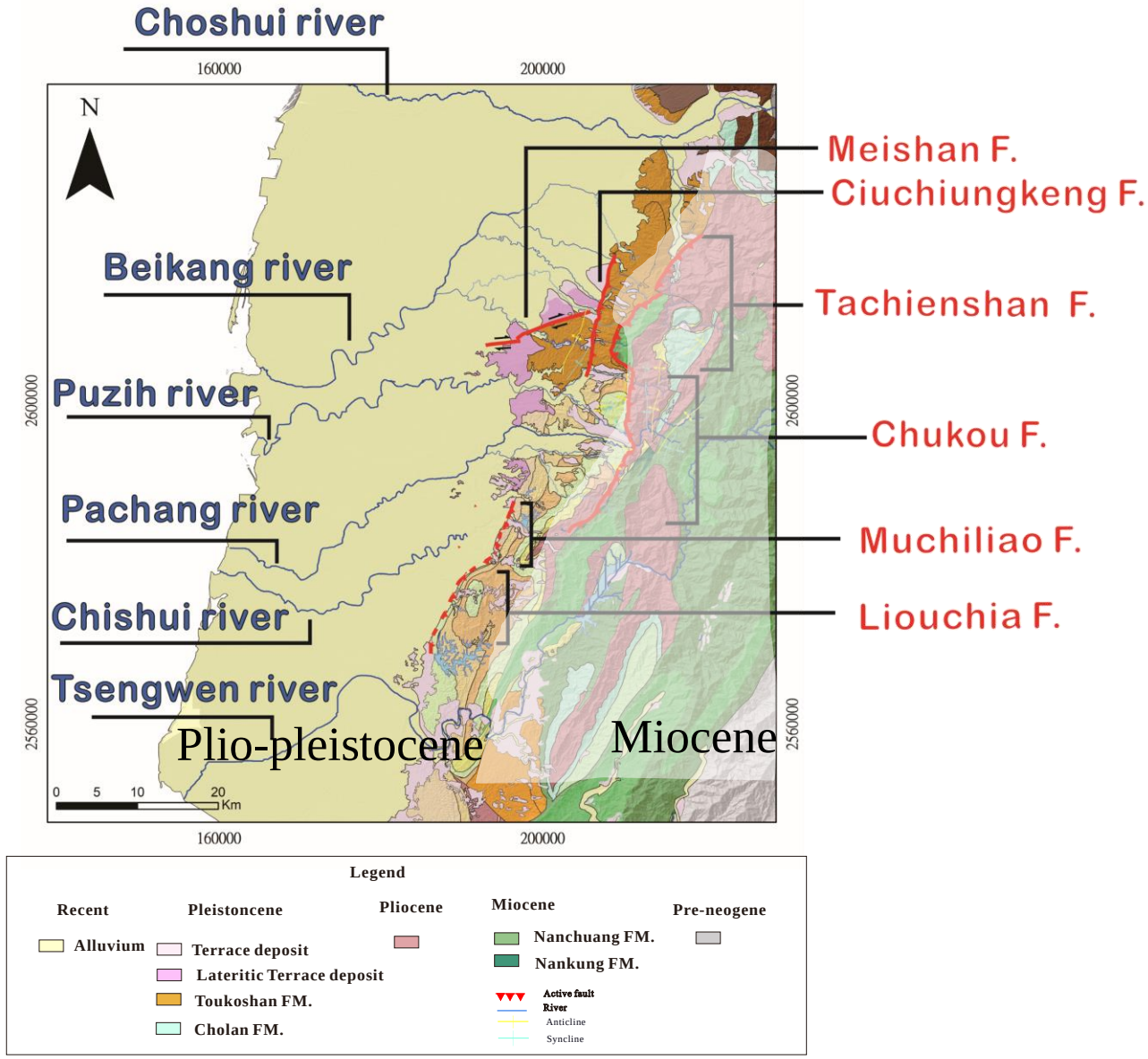
1. The velocity field shows active westward compression in the Chiayi-Tainan area.

Introduction

Geological setting

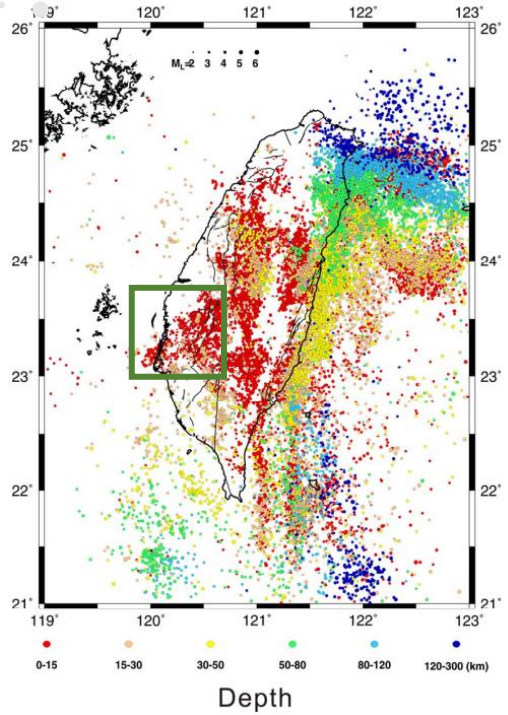


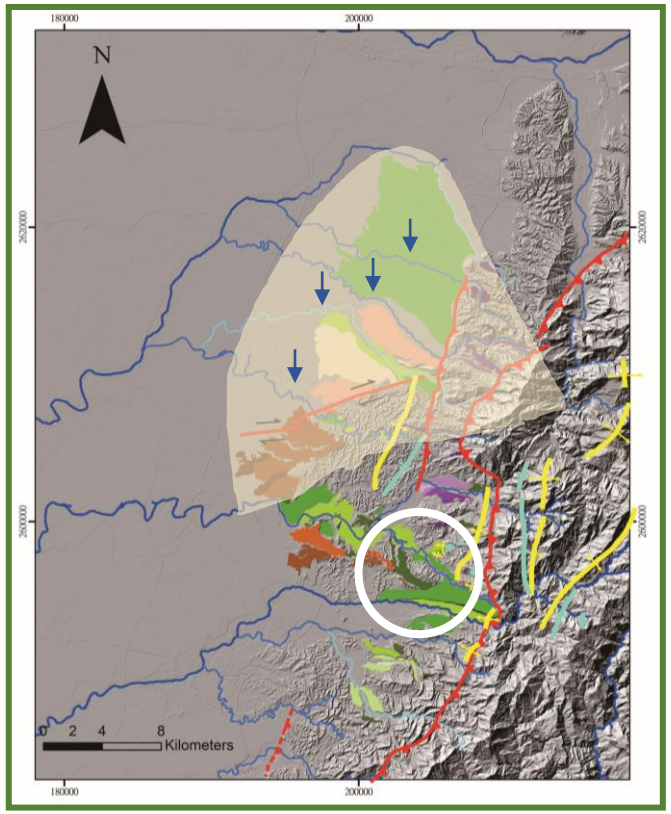
Topography Map

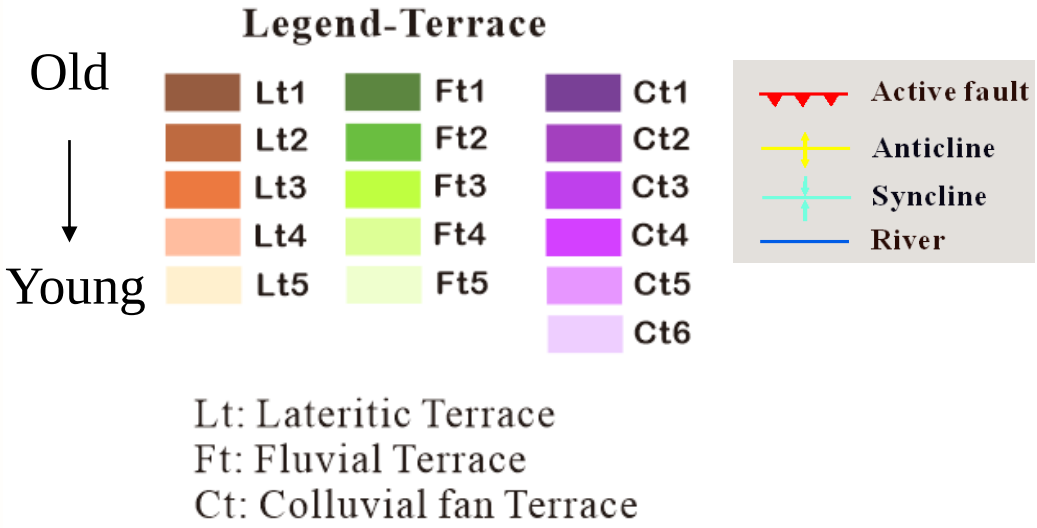


Geological Map(Modified after CPC 1/100000 geological map, 1986)

Introduction







(Modified after Feng, 2004)

Motivation from landscape

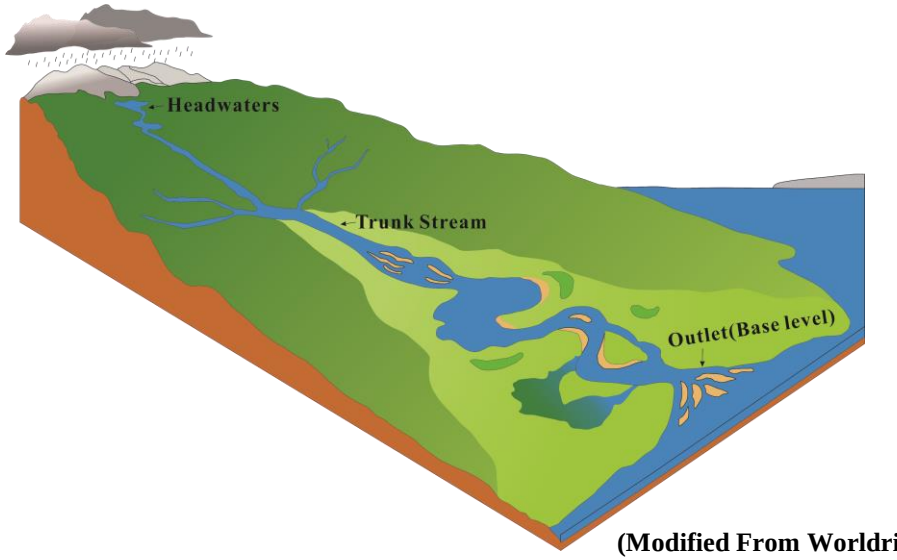
1. There are large residual alluvial deposits, but most of the present rivers are too short.
   -Large River → Alluvial fan size

2. There are abandoned geomorphic surfaces, but there has been no active structure mapped.
   -Uplifted and folded area → existence of active structures

Introduction

What forms the landscape?

The river is the most important driver to the landscape changes.



(Modified From Worldrivers)

Core concepts

- To find anomalies from the drainage system and geomorphic surfaces changes to investigate the tectonics. This methods is so-called geomorphometry.

Purpose:

- To correlate morphology and tectonics, then we can determine the evolution of the morphotectonics.

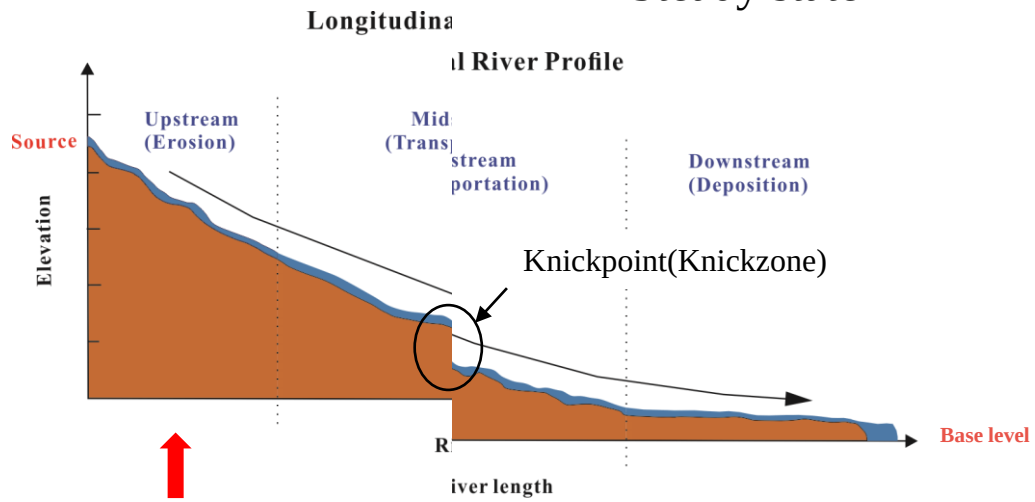
- When are the structures active? How did the rivers respond on the landscape?

Basic Concept

Active Tectonics
Folds or Faults
↓
Slope
↓
Fluvial systems
rapid response
↓
River profile | Terrace | Channel Type
↓
Landscape

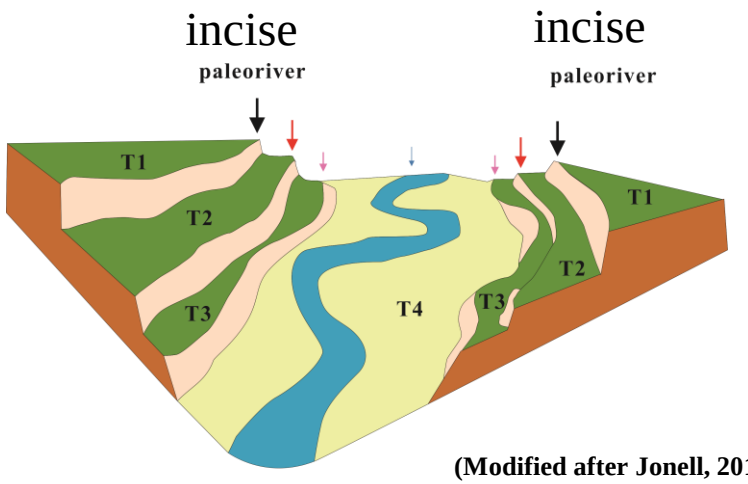
When the river crosses through the uplift area, the channel sinuosity will typically becomes larger. -(Burbank&Anderson, 2012)

~~Steady state~~



(Modif after River Systems and Landforms Geosystems 5)

River migrate

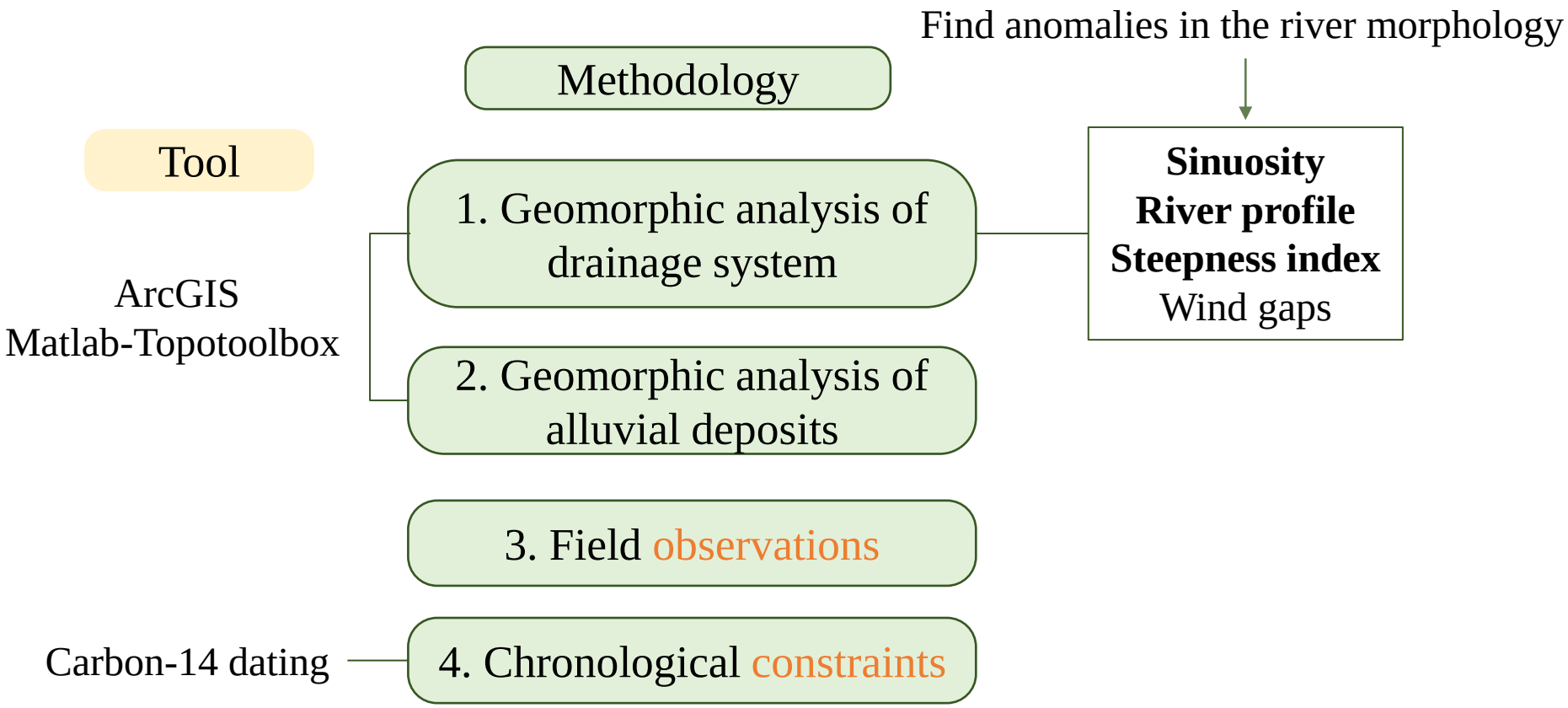


(Modified after Jonell, 2012)

Slope

Sinuosity

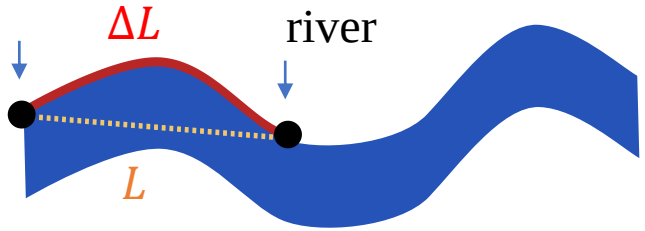
Methodology



Sinuosity and River profile

- Sinuosity :The sinuosity is the actual river length divided by the shortest path length.

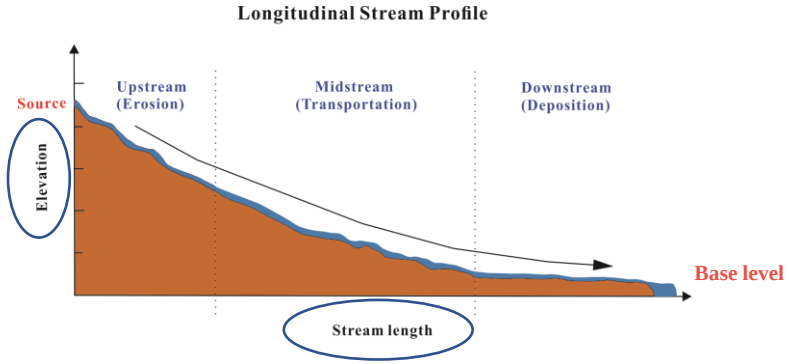
$$Sinuosity = \frac{River\ Lenth\ (\Delta L)}{Straight\ Line\ Length\ (L)}$$

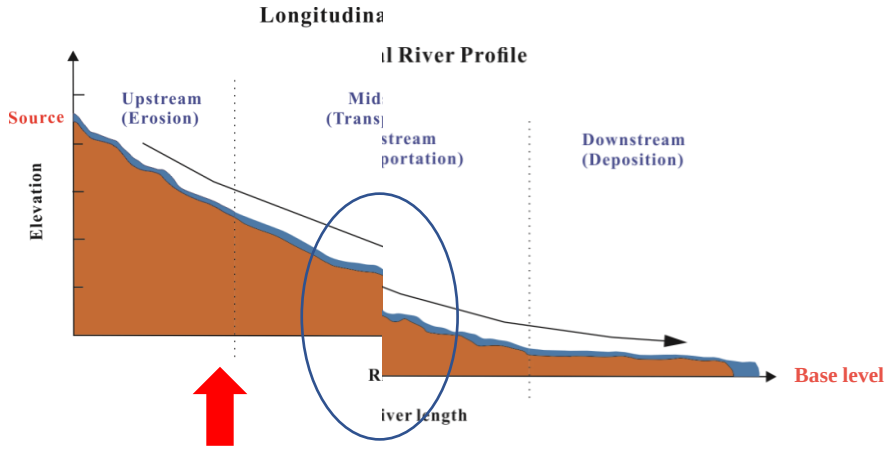


*Sinuosity changes can reveal river stretches affected by tectonic uplift.

-When river crosses through the uplift area, the value will become larger.

- River profile





*The river profile is perfect exponential curve during the steady state.

- When river cross through the uplift area, it will have a slope break or knickpoint.

Steepness index(ksn)

How to identify the knickpoint?

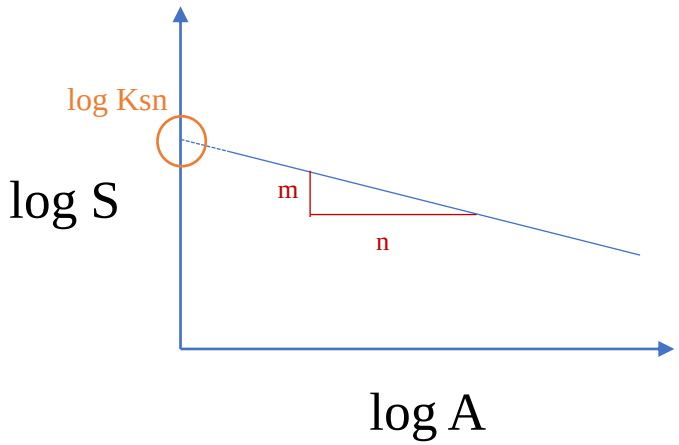
Hack's Law

- $\frac{dz}{dt} = U - kA^m \times (\frac{dz}{dx})^n$

Uplift Erosion

k: erodibility
A=catchment area
S= slope

$if\ \theta = 0$



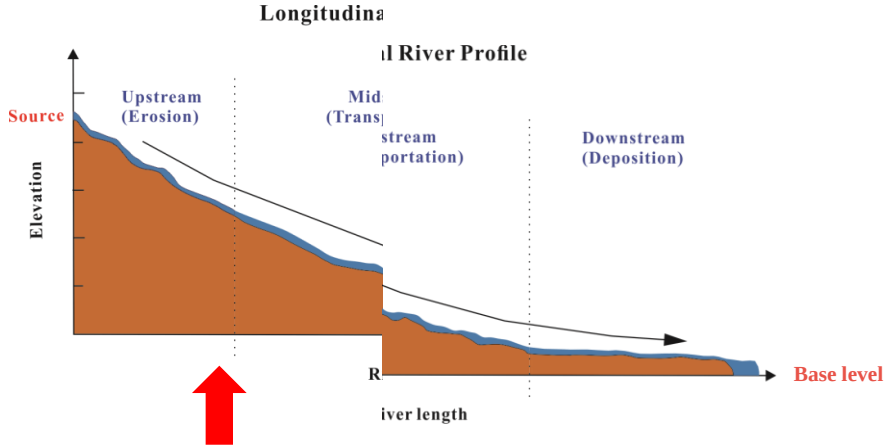
- Steady state : $\frac{dz}{dt} = 0 = U - kA^m \times (\frac{dz}{dx})^n$

Equilibrium : uplift = erosion

- $\frac{U}{k} = \frac{S}{A^{-\theta}}$, $k_{sn} = \frac{U}{k}$, $\theta = m/n$

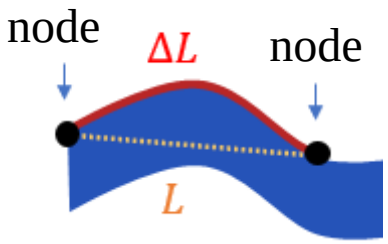
Steepness index Concavity index

Upstream k_{sn} > Downstream k_{sn}

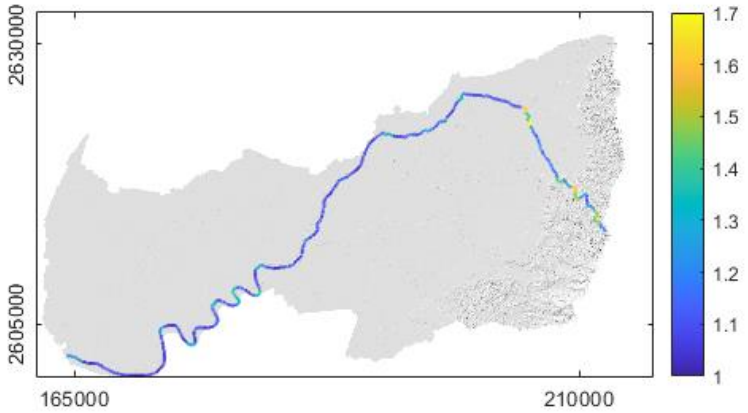


Preliminary results

Pachang River



node= 1000



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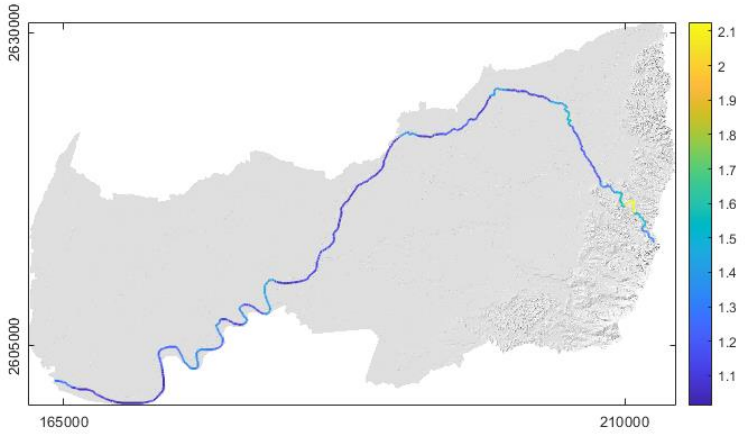
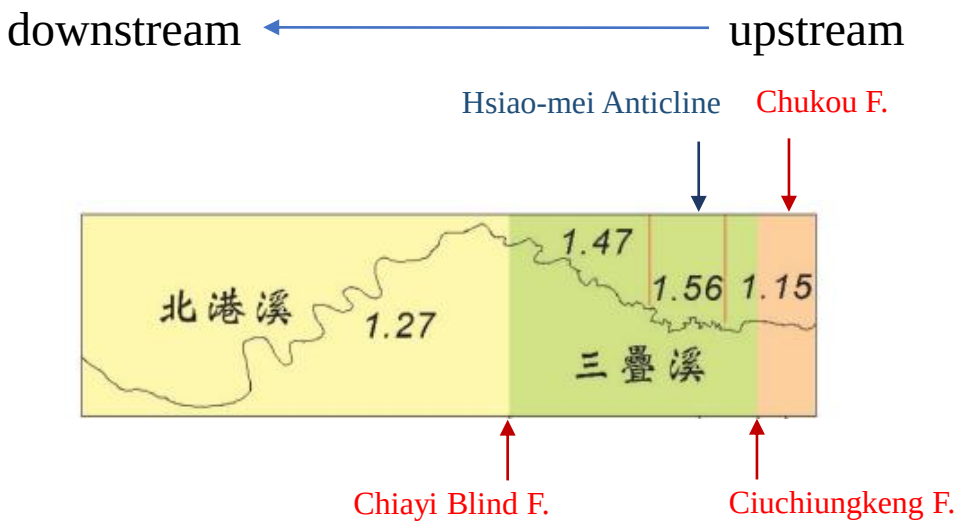


Sinuosity

Goal

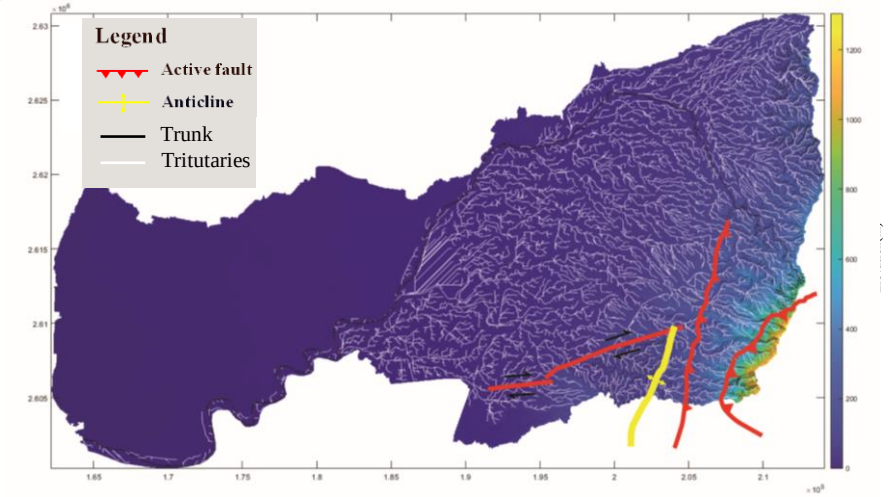


Sinuosity analysis of Beigang-Sandie river(Chen et al., 2004)

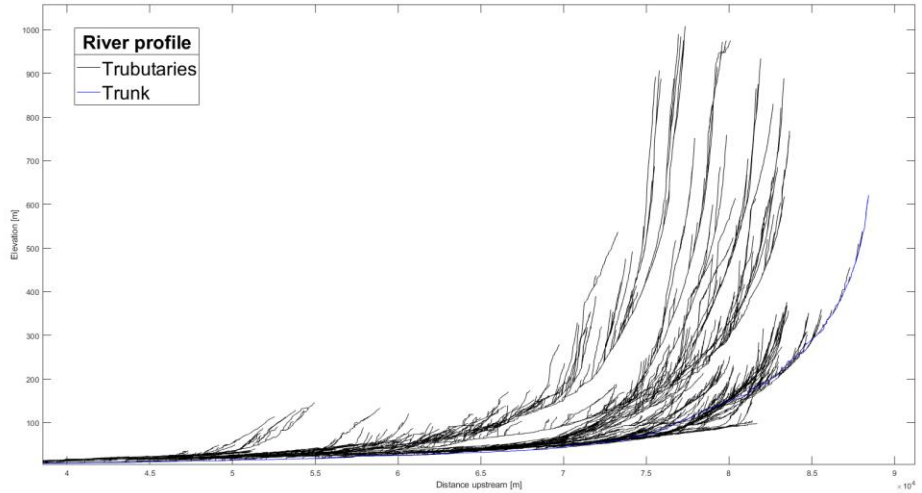
- The number represent the sinuosity.
- The location of the increasing sinuosity correlates well with the location of the Hsiao-Mei anticline.

Preliminary result

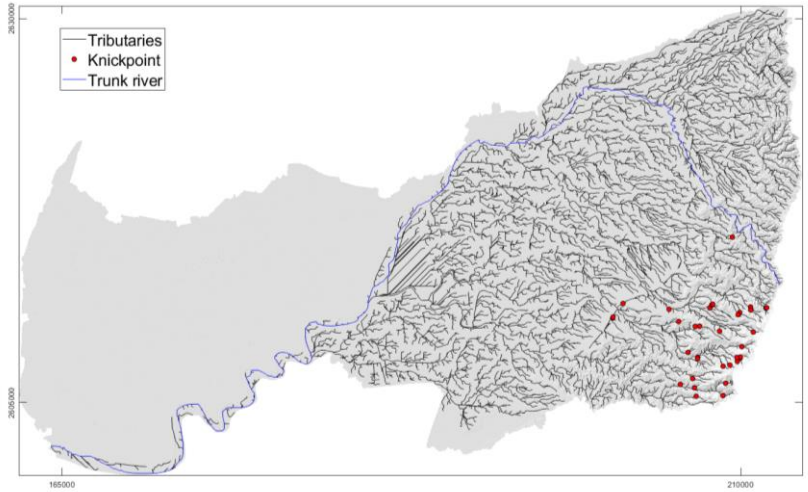
River profile and knickpoint identification



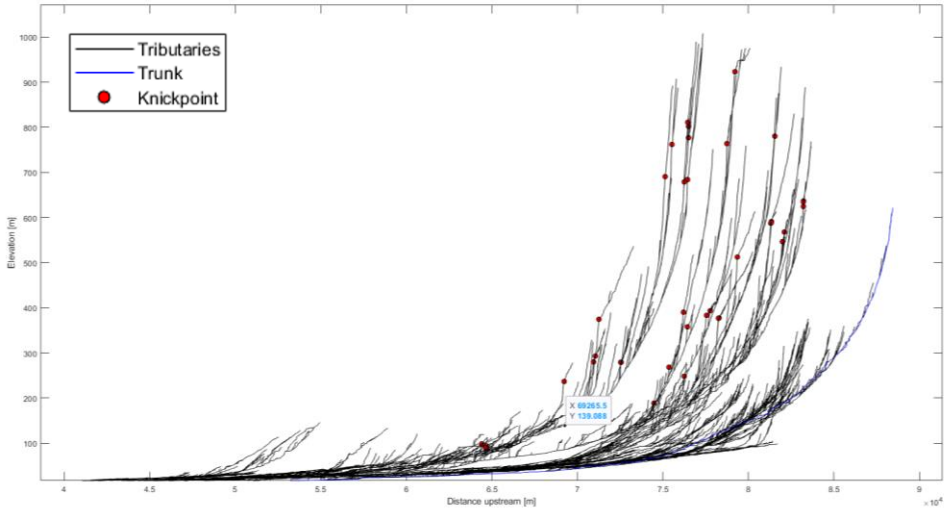
Topography of Beigang river



Longitudinal river profile of Beigang River



Knickpoint distribution of Beigang river (Map view)



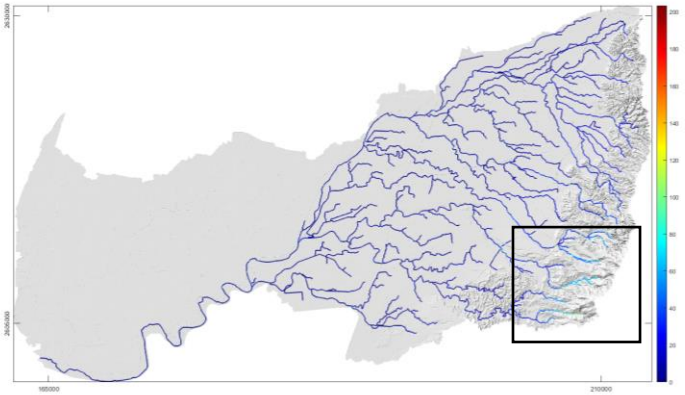
Knickpoint distribution of Beigang river (longitudinal river profile)

Preliminary result

Steepness index(ksn)

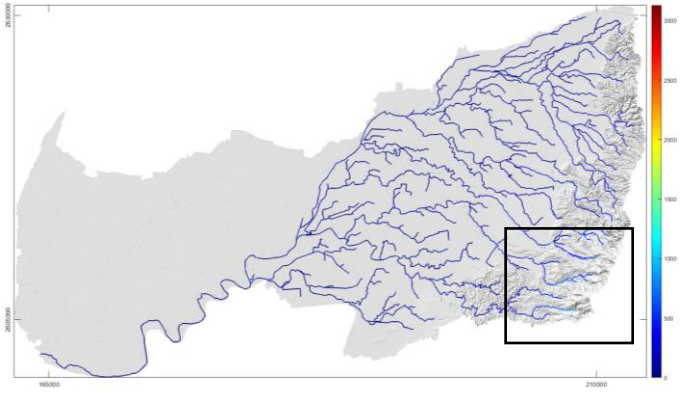
Beigang River

θ= 0.45



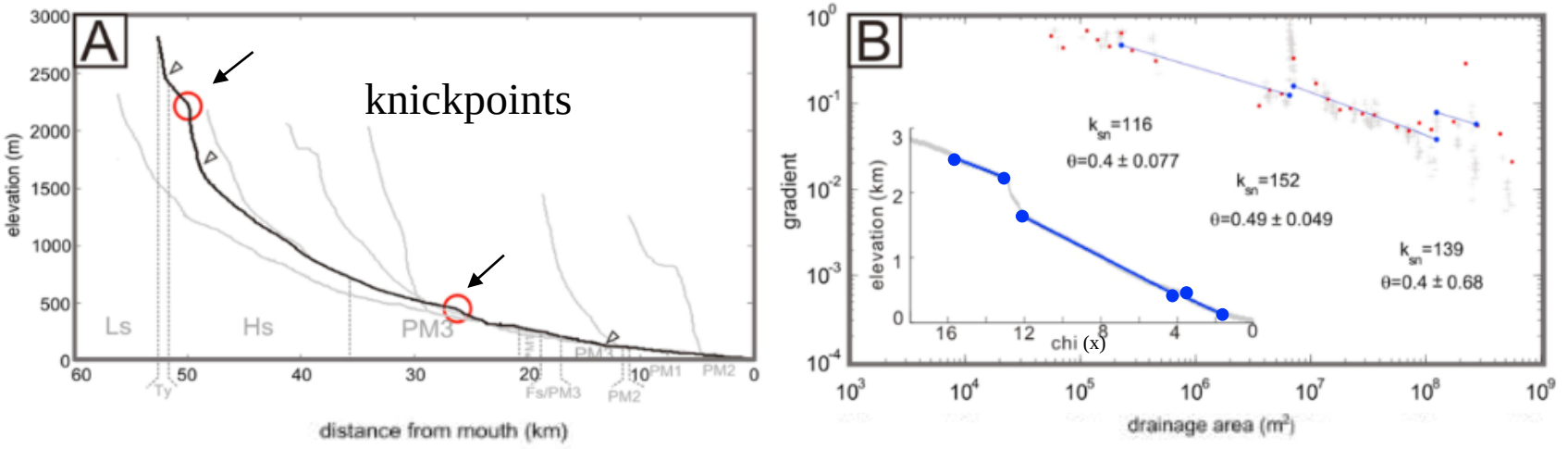
ksn

θ= 0.6



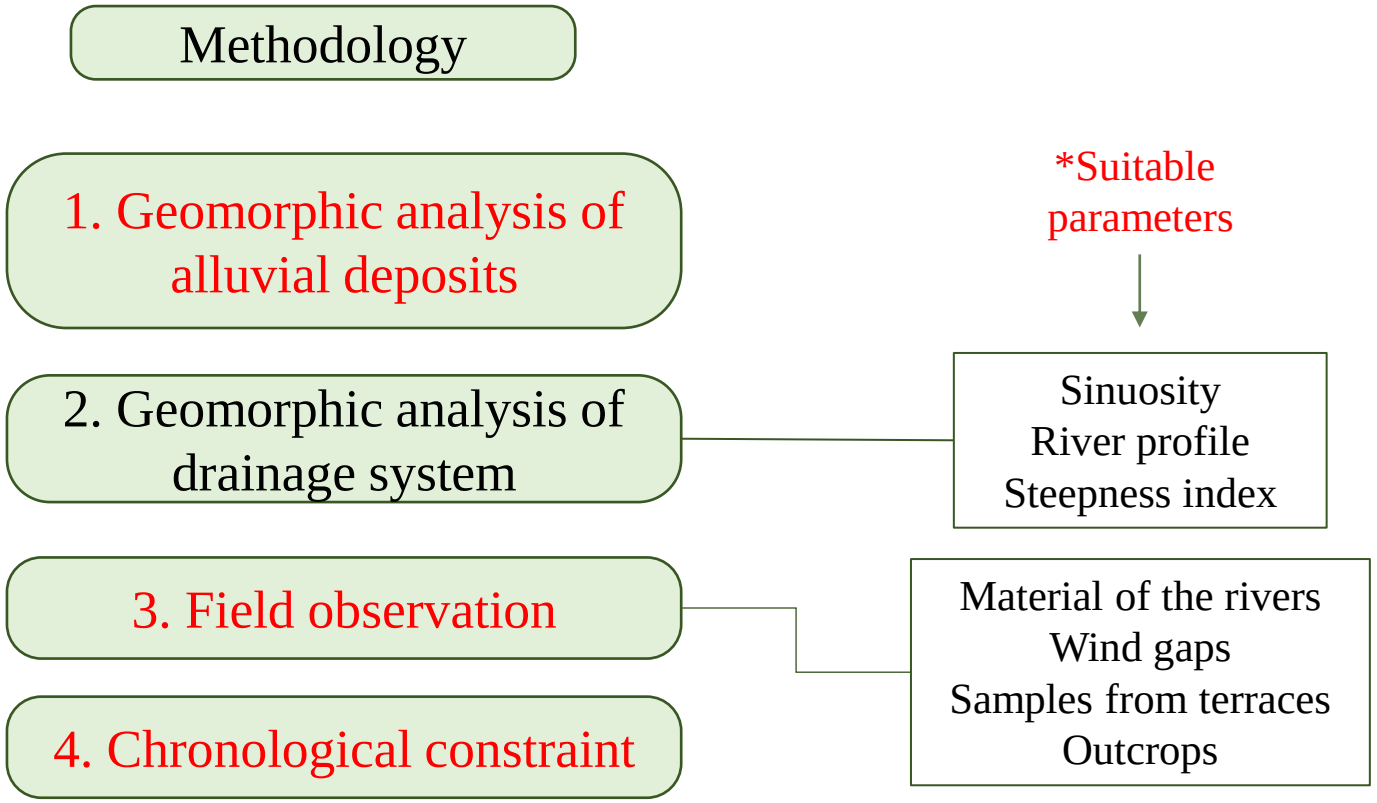
ksn

Example



Eastern flank of Central Range in Taiwan (Chen et al., 2015)

Future Work


Methodology
1. Geomorphic analysis of alluvial deposits
2. Geomorphic analysis of drainage system
3. Field observation
4. Chronological constraint
*Suitable parameters
Sinuosity
River profile
Steepness index
Material of the rivers
Wind gaps
Samples from terraces
Outcrops

Thank you for your attention.