Effect of Riverbed Degradation and Aggradation on Transformation of Alternate Bar Morphology

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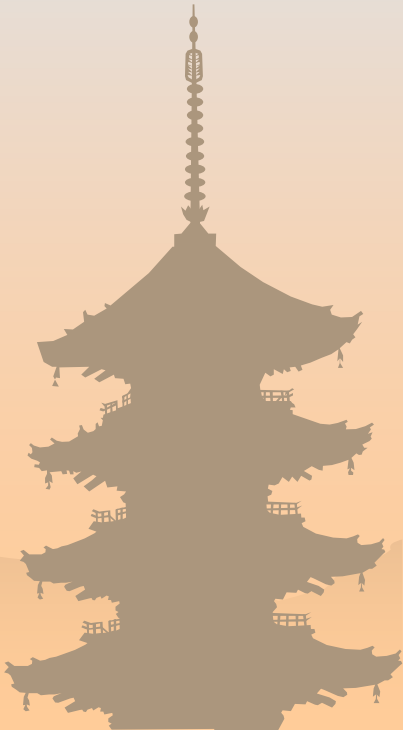


Background of Study

- Many studies on alternate bars have been conducted under equilibrium sediment supply conditions, and discussed phenomena in equilibrium states.
- Bar morphology in rivers is not always formed under such conditions. And, an imbalance between sediment transport capacity and sediment supply rate influences variation in the bar morphology.
- It is important to investigate how the bar morphology formed by some water and sediment discharge condition varies by the other conditions.

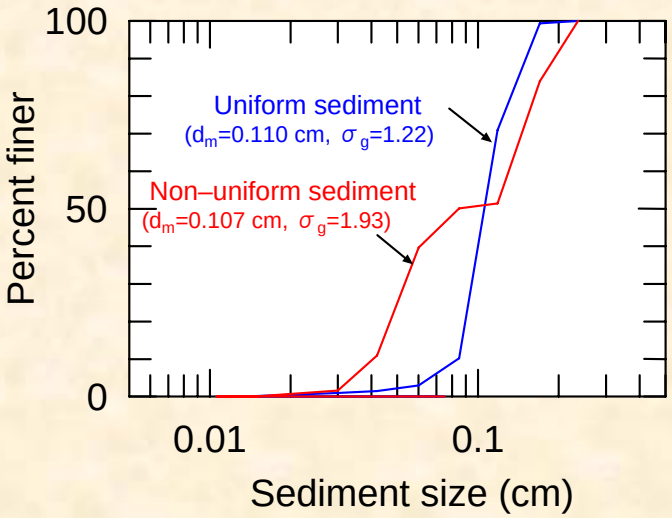
Purposes of Study

- ☆ Investigation of effects of bed degradation and aggradation on variation in alternate bar morphology
- ☆ Investigation of effects of water discharge and grain sorting on that variation

Contents of Presentation

1. Experiment
2. Variation in alternate bar morphology with degradation and aggradation
   - ※ *Temporal changes in longitudinal bed profile and bed topography*
   - ※ *Variation in bar wavelength and height*
3. Change of bar regime due to changes of bed slope and water discharge
4. Conclusions

Experiments 1



Grain size distributions

Step 1

Formation of stable alternate bars
(Q_w=400cm³/s, 800cm³/s, sediment supply)

Low-water discharge

High-water discharge

Initial bed in this study

same water discharge

Step 2

Variation in alternate bar morphology
(Q_w=400cm³/s, 800cm³/s, Qs=0, 0.5Q_{se}, 3Q_{se})

Main object in this study

Experiment procedure

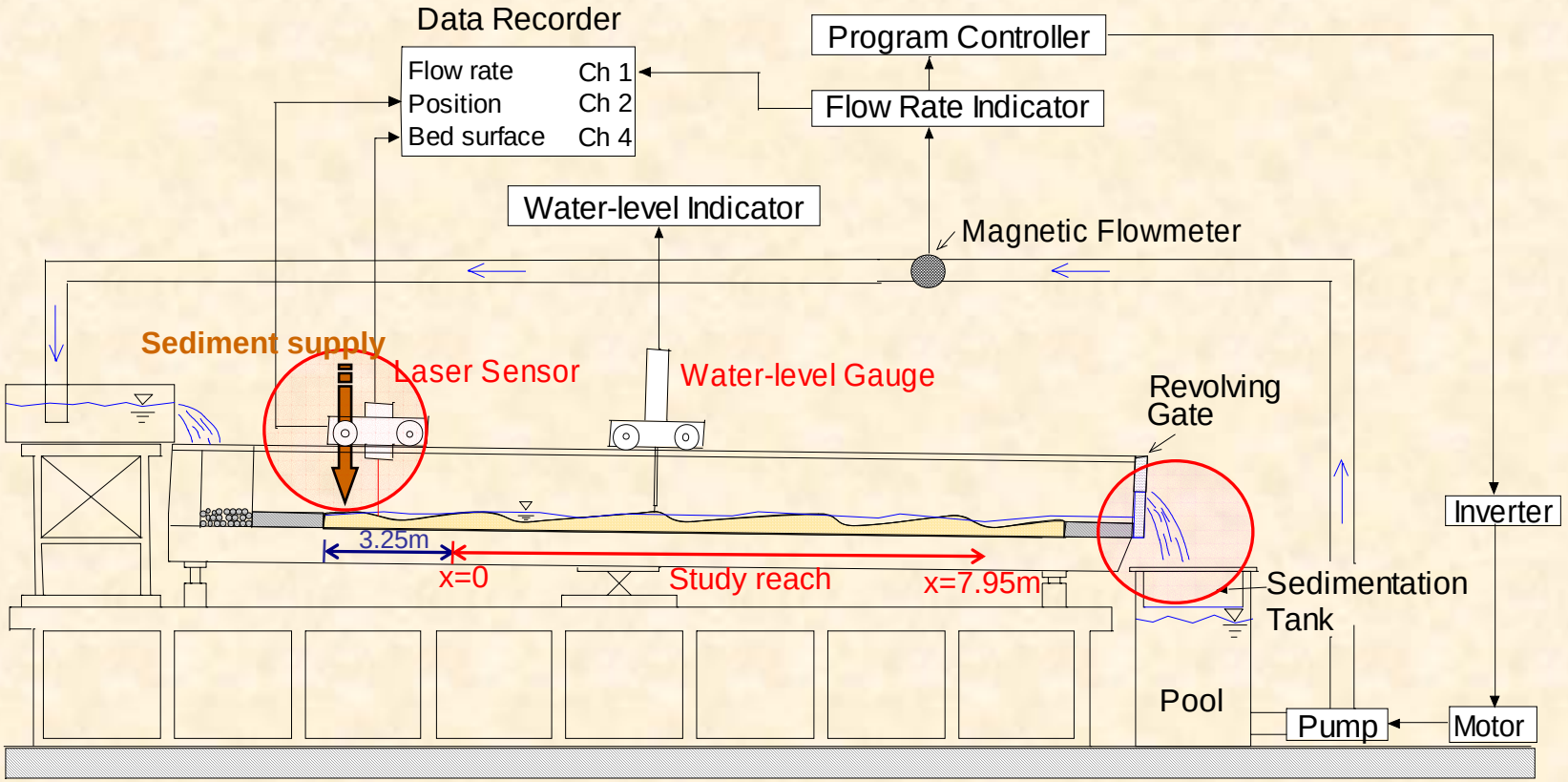
Equilibrium sediment supply rate in step 1

Case 1 : Q_w=400cm³/s, Q_s=0 (degradation) → Degradation downstream of dam

Case 2 : Q_w=800cm³/s, Q_s=0.5Q_{se} (degradation) → Sediment flushing from dam

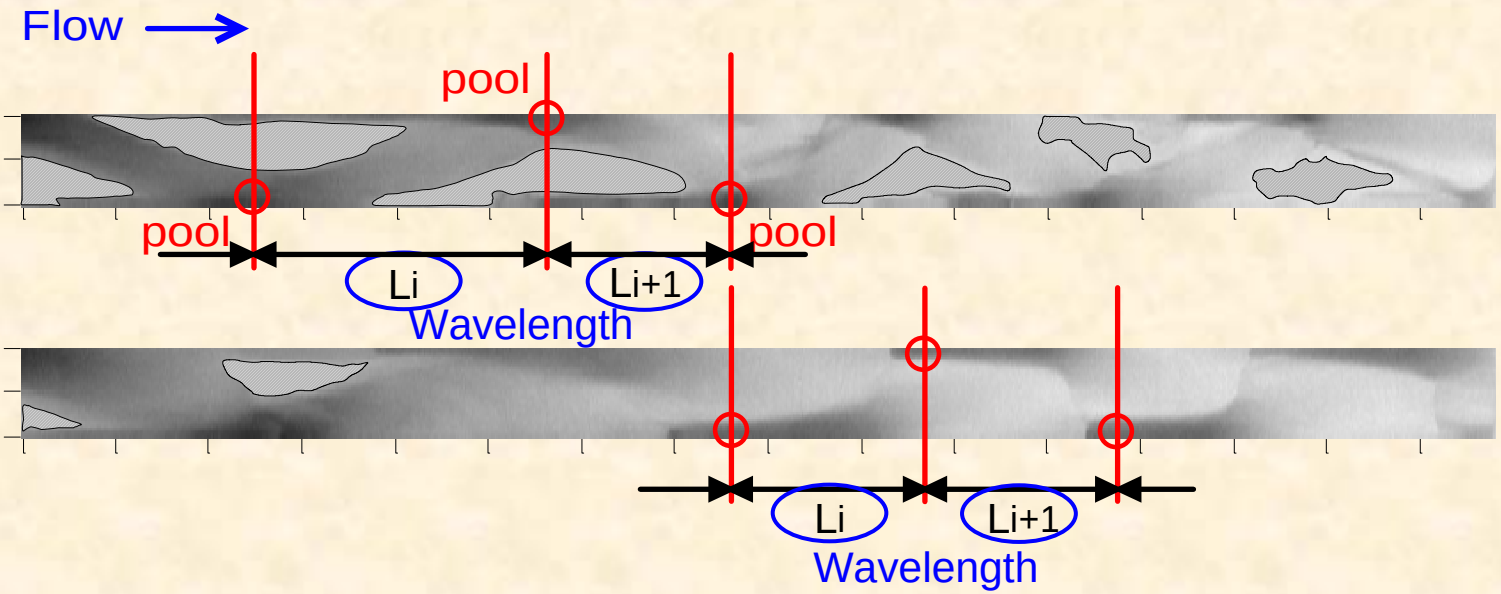
Case 3 : Q_w=800cm³/s, Q_s=3Q_{se} (aggradation) → Sediment flushing from dam

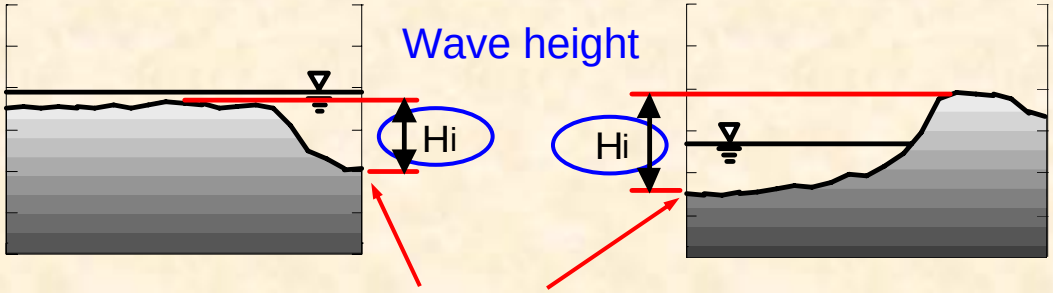
Experiments 2



Experimental set-up

Definitions of wavelength and height





Lowest bed level in an individual wavelength

The number of an individual wave in the reach

Mean wavelength : $L = \frac{1}{N}\sum_{i=1}^{N} L_i$

Mean wave height : $H = \frac{1}{N}\sum_{i=1}^{N} H_i$

Variation in alternate bar morphology with degradation and aggradation

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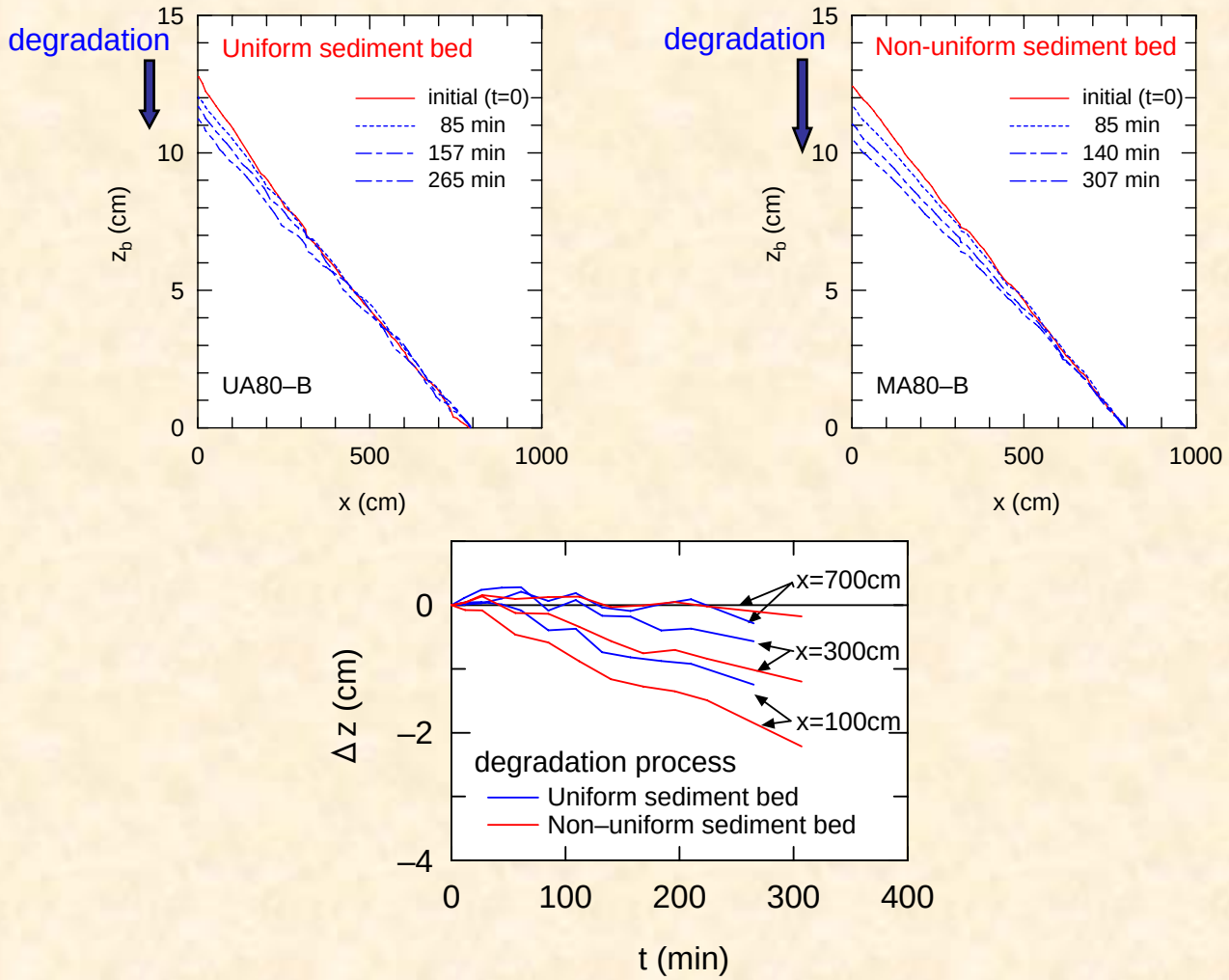
Temporal variation in longitudinal bed profile and degradation rate

High-water discharge

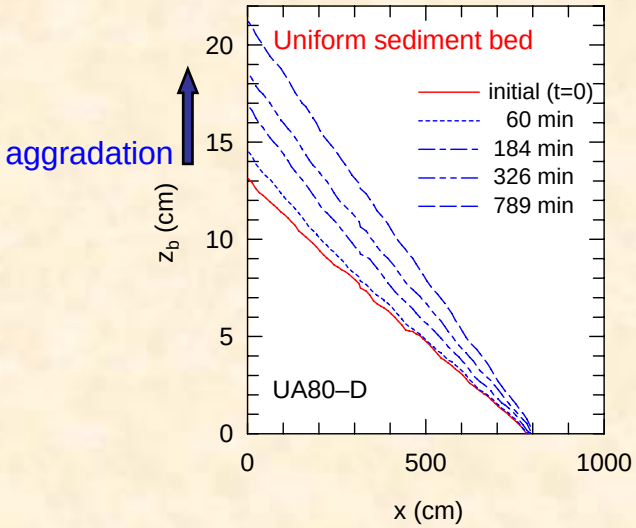
Case 2

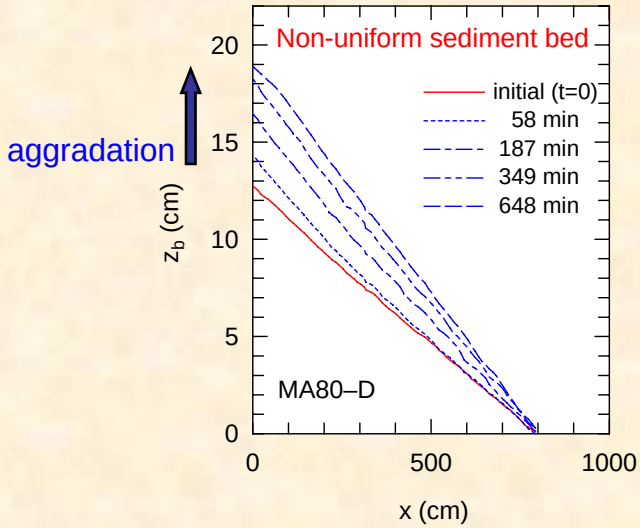


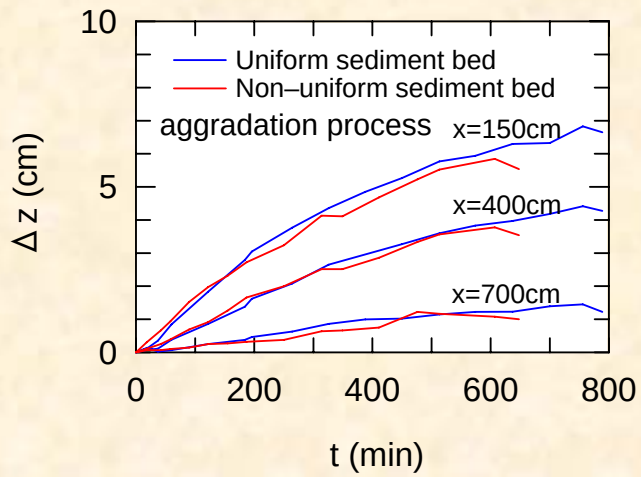
Temporal variations in longitudinal bed profile and aggradation rate

High-water discharge

Case 3







Variation in Bar Morphology in Degradation Process

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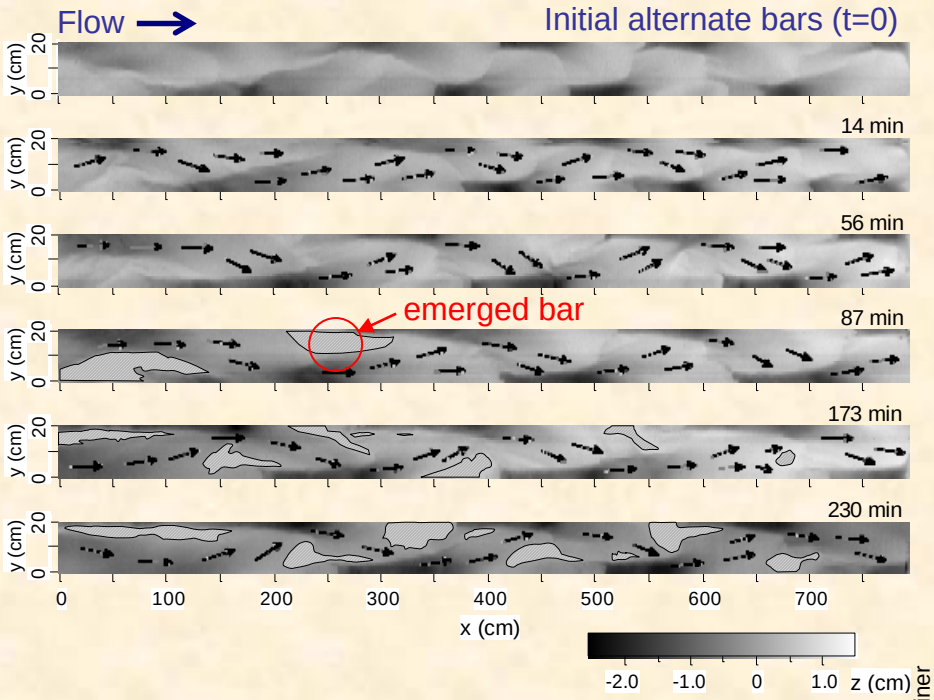
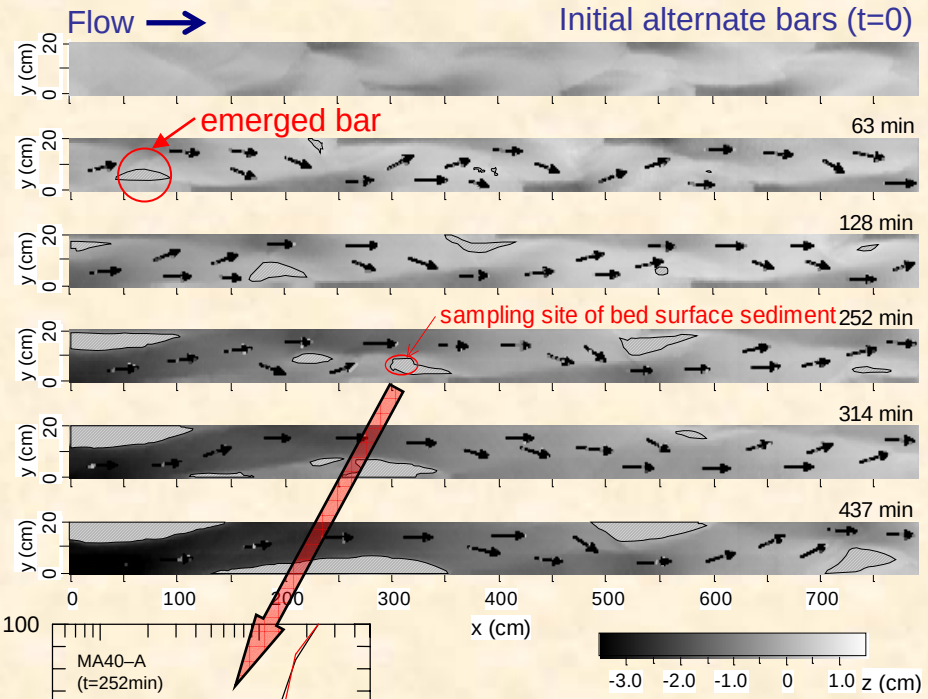
Variation in bar morphology in degradation process under low-water discharge

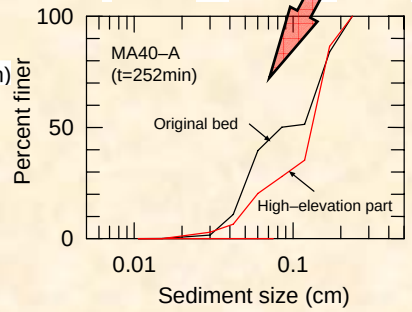
Case 1



Uniform sediment bed



Non-uniform sediment bed



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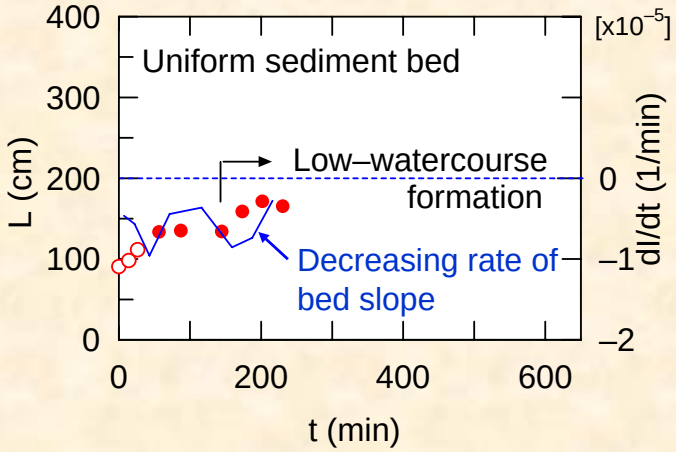
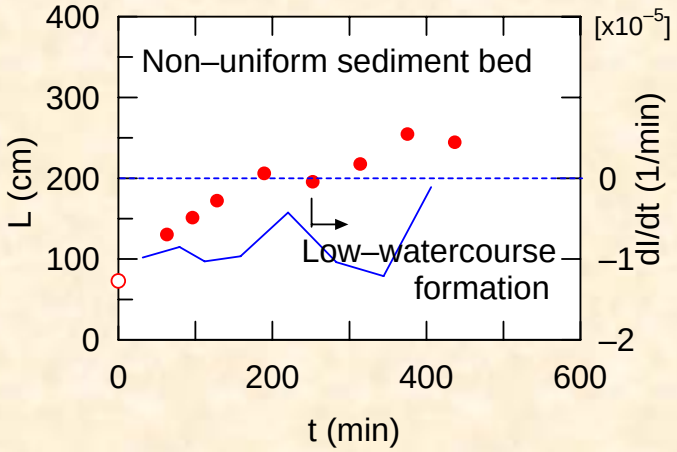
Temporal variations in wavelength and height

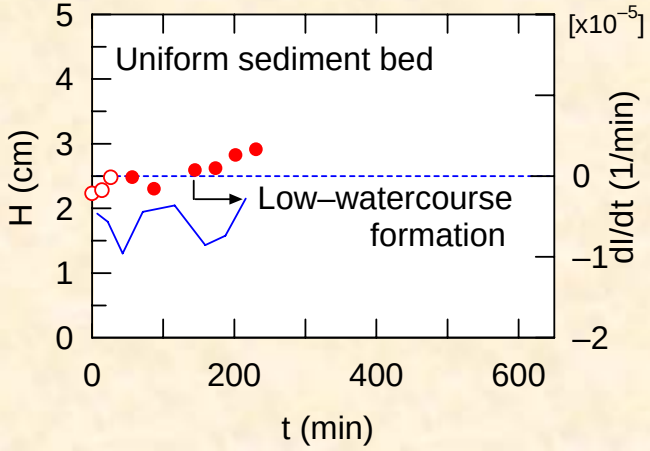
Case 1

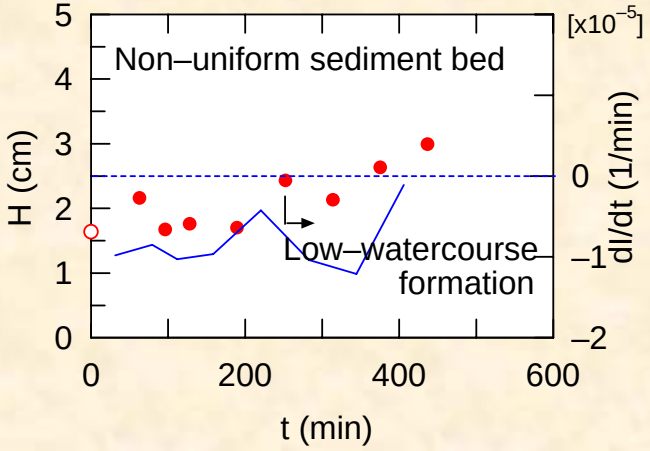
Wavelength





Wave height



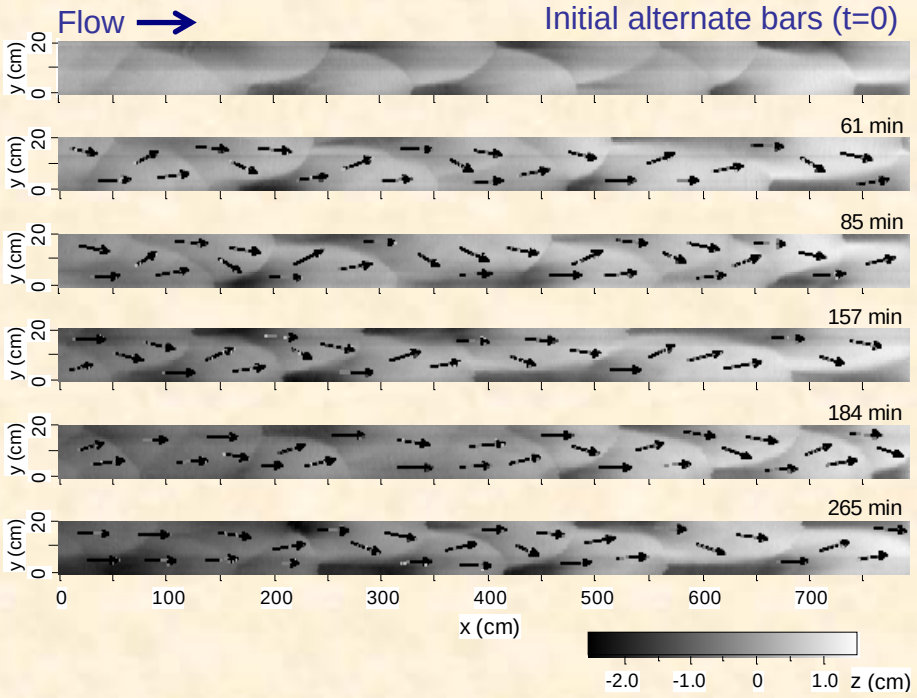


Uniform sediment bed

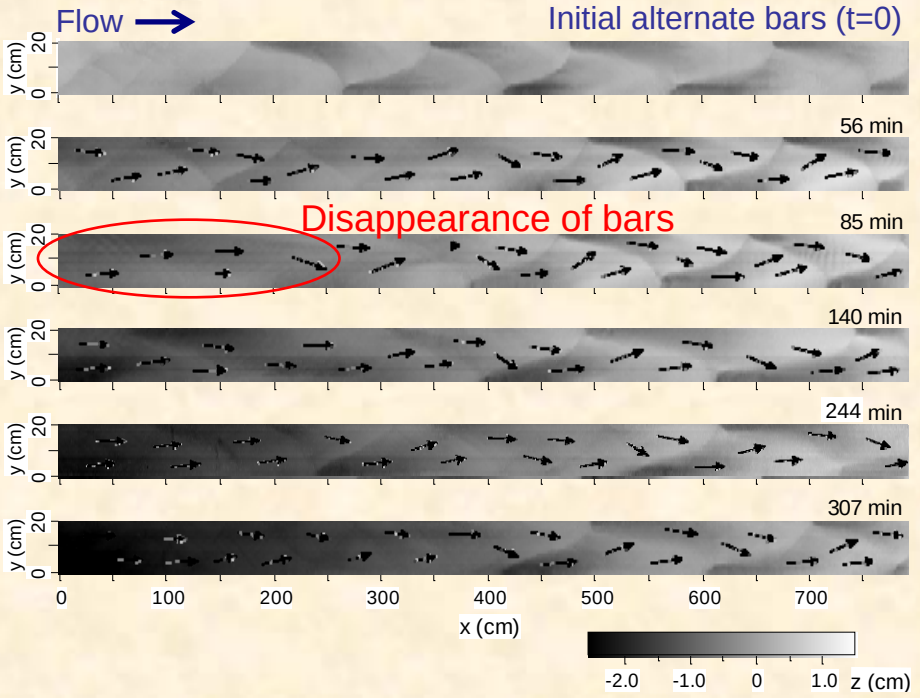
Non-uniform sediment bed

Variation in bar morphology in degradation process under high-water discharge

Case 2



Uniform sediment bed

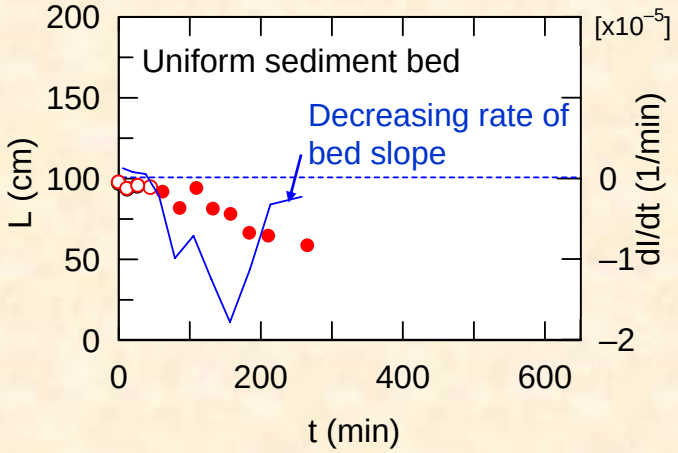


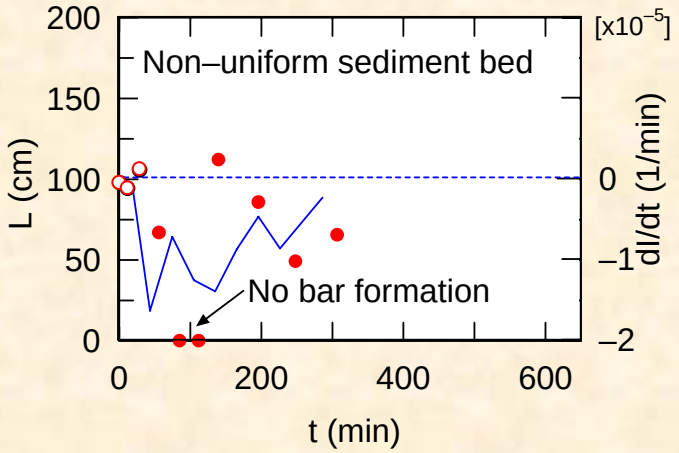
Non-uniform sediment bed

Temporal variations in wavelength and height

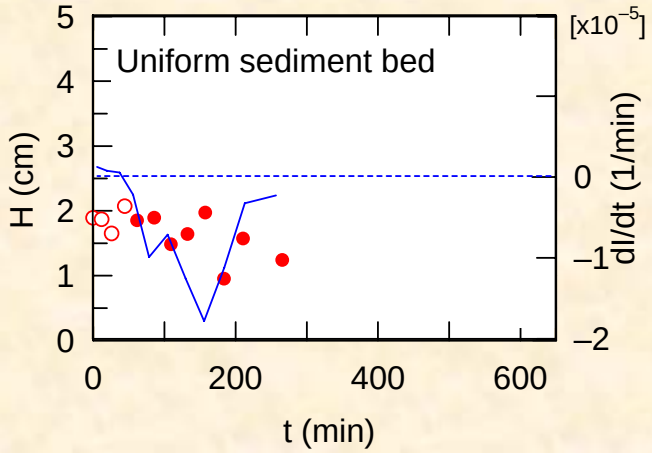
Case 2

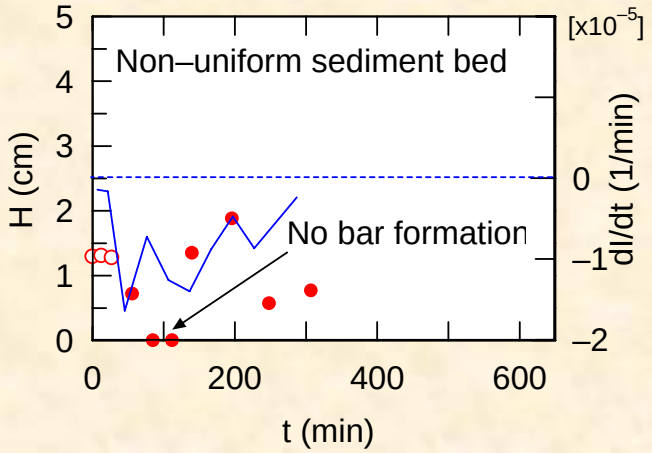
Wavelength





Wave height





Uniform sediment bed

Non-uniform sediment bed

Variation in Bar Morphology in Aggradation Process

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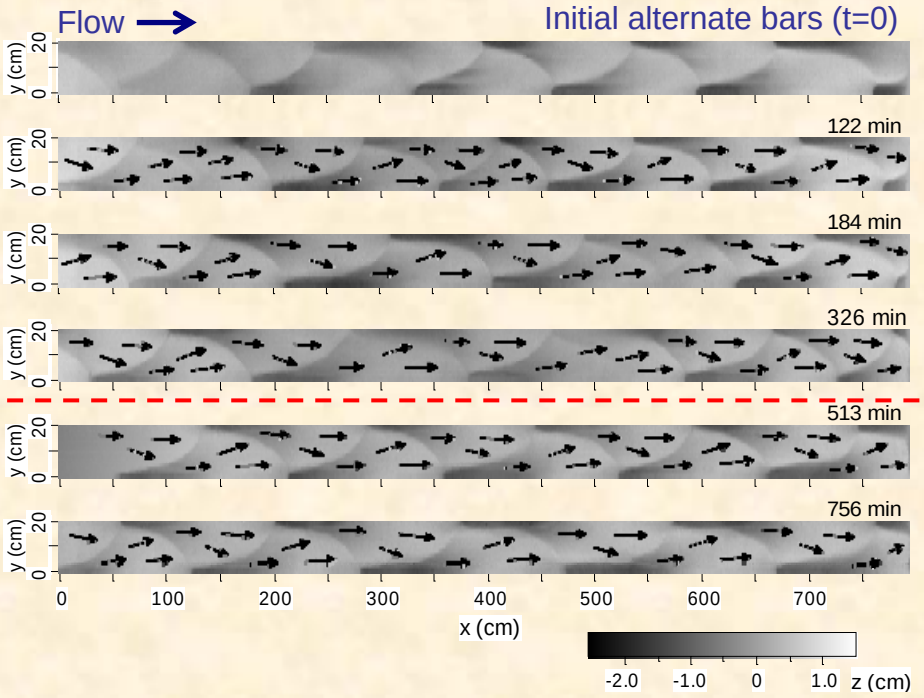
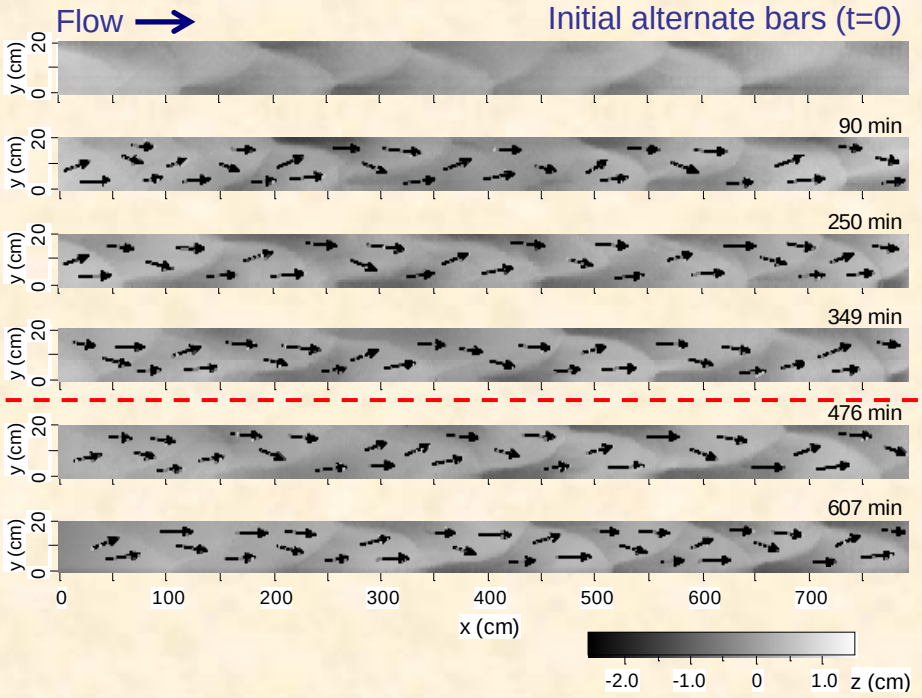
Variation in bar morphology in aggradation process under high-water discharge

Case 3



Uniform sediment bed

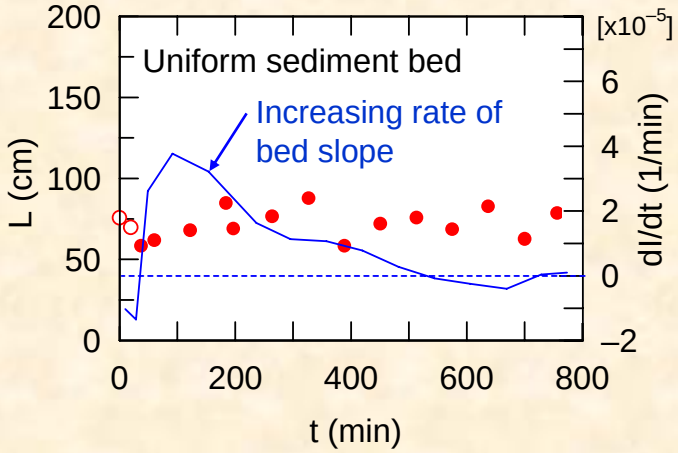


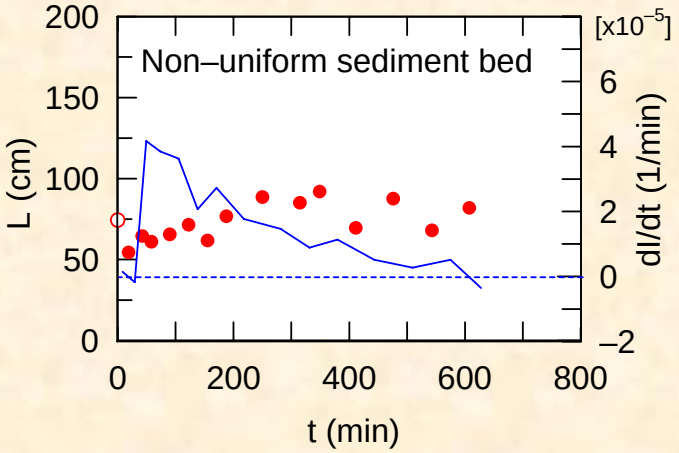
Non-uniform sediment bed

Temporal variations in wavelength and height

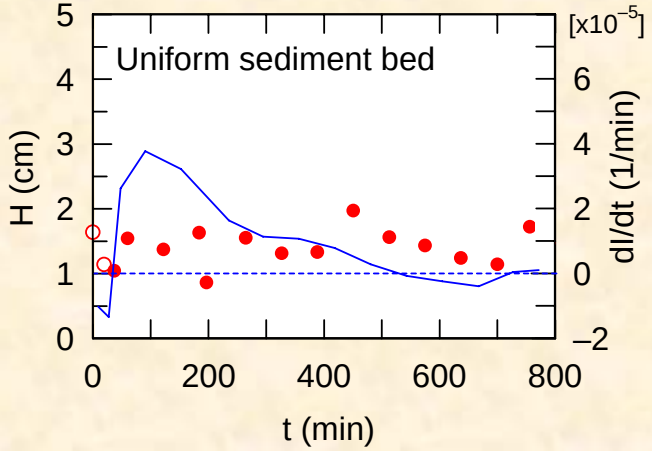
Case 3

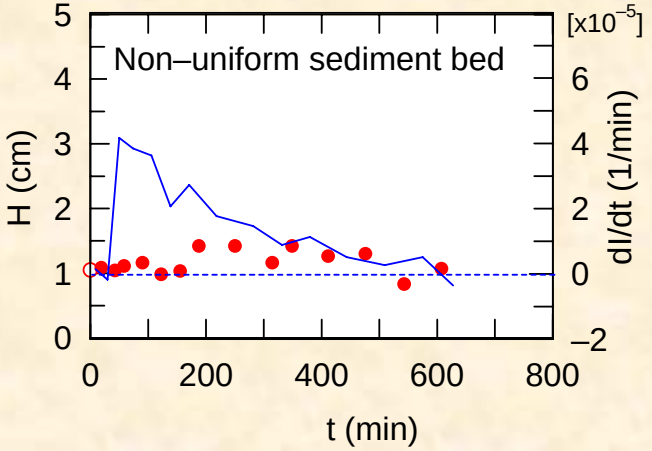
Wavelength





Wave height





Uniform sediment bed

Non-uniform sediment bed

Change of Bar Regime due to Changes of Bed Slope and Water Discharge

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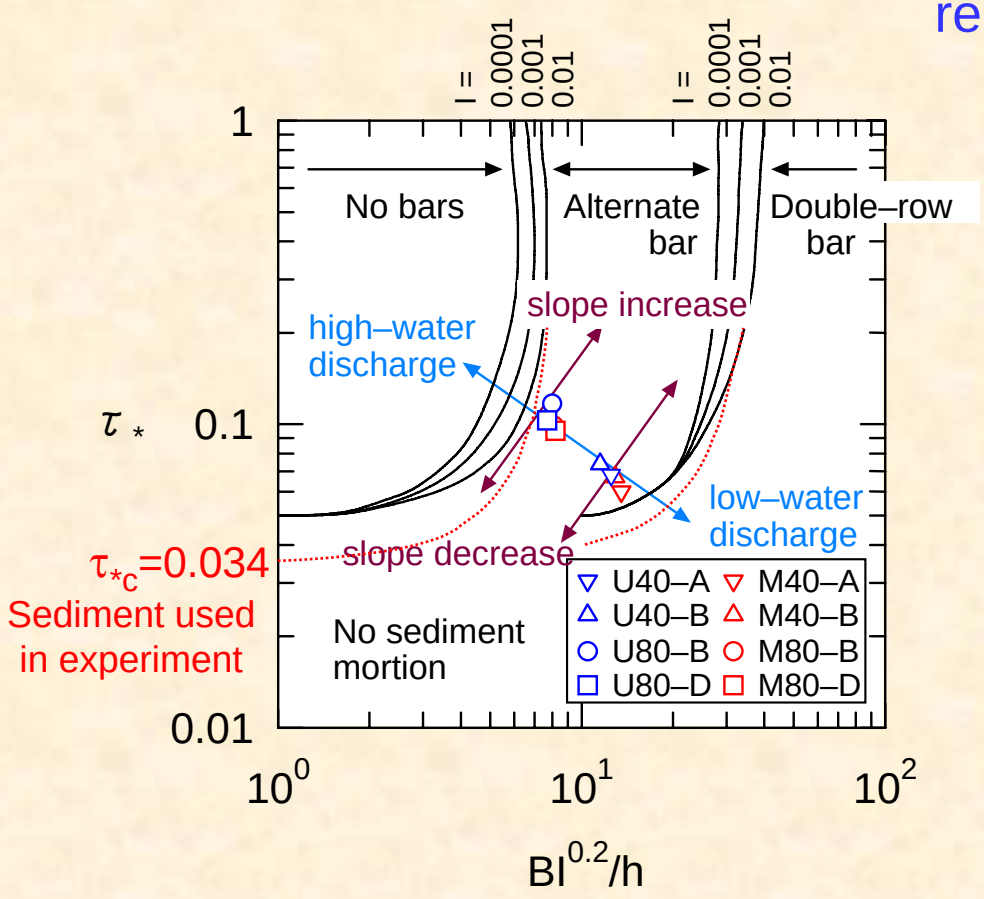
Change of bar regime variables due to changes of bed slope and water discharge

Kuroki & Kishi's
regime criteria diagram



Conclusions

The riverbed degradation under the low-water discharge causes the low-watercourse formation, and that under the high-water discharge causes the restriction of alternate bar development. In addition, the aggradation under the high-water discharge causes the increase of the alternate bar wavelength.

The increase and the decrease of wavelength of alternate bars in consequence of the riverbed degradation are remarkable in the non-uniform sediment bed.

Not only bed slope but also its changing rate affects variation in bar morphology.

The migration velocity of the alternate bars decreases with bed degradation, and that increases with aggradation. The decrease of migration velocity relates to the immobilization of alternate bars and the formation of low-watercourse.