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Sediment Transport

Qizhong (George) Guo, Ph.D., P.E., B.C.WRE, Professor
Department of Civil and Environmental Engineering
School of Engineering, Rutgers University-New Brunswick

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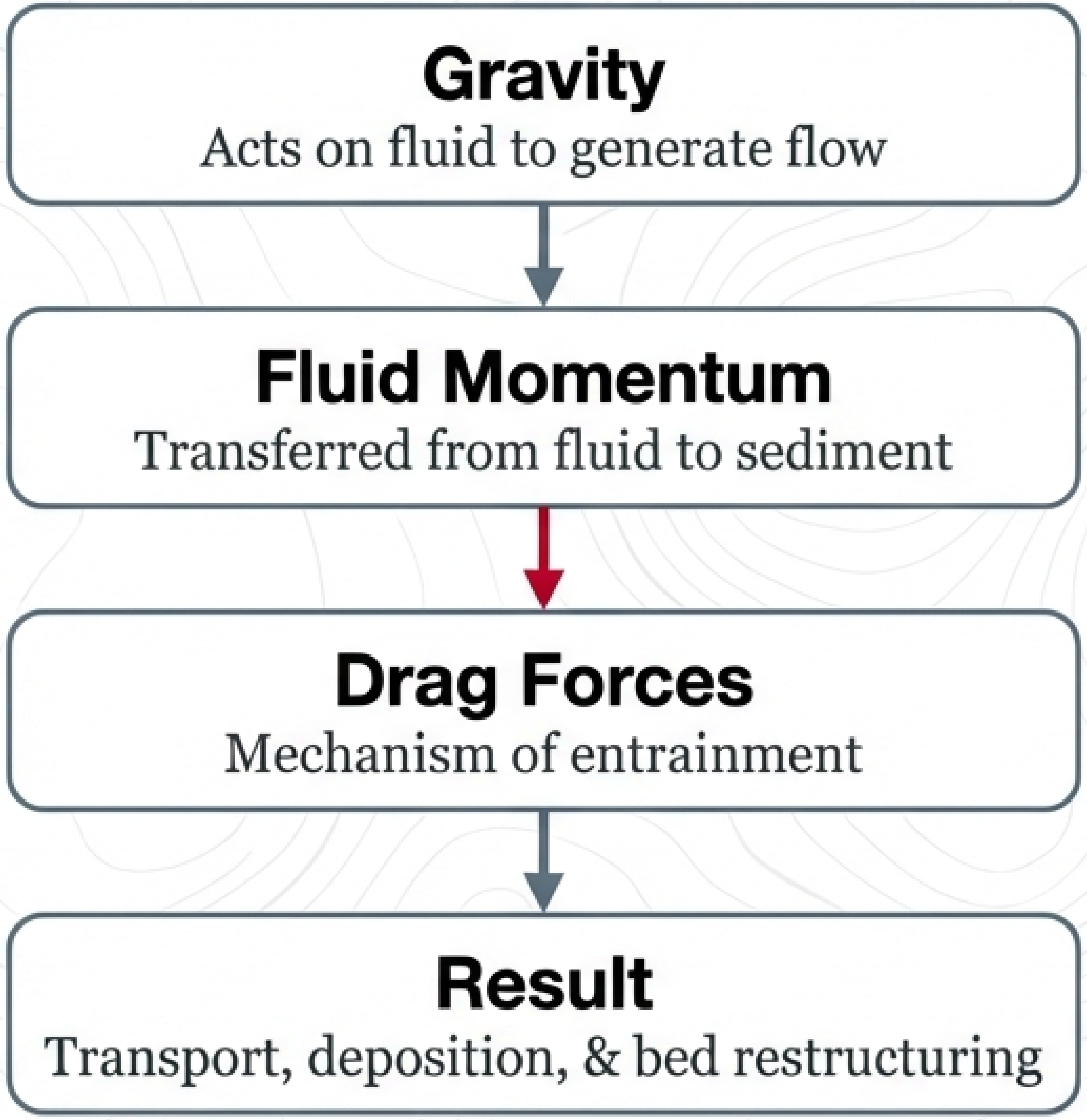
The Physics of Motion

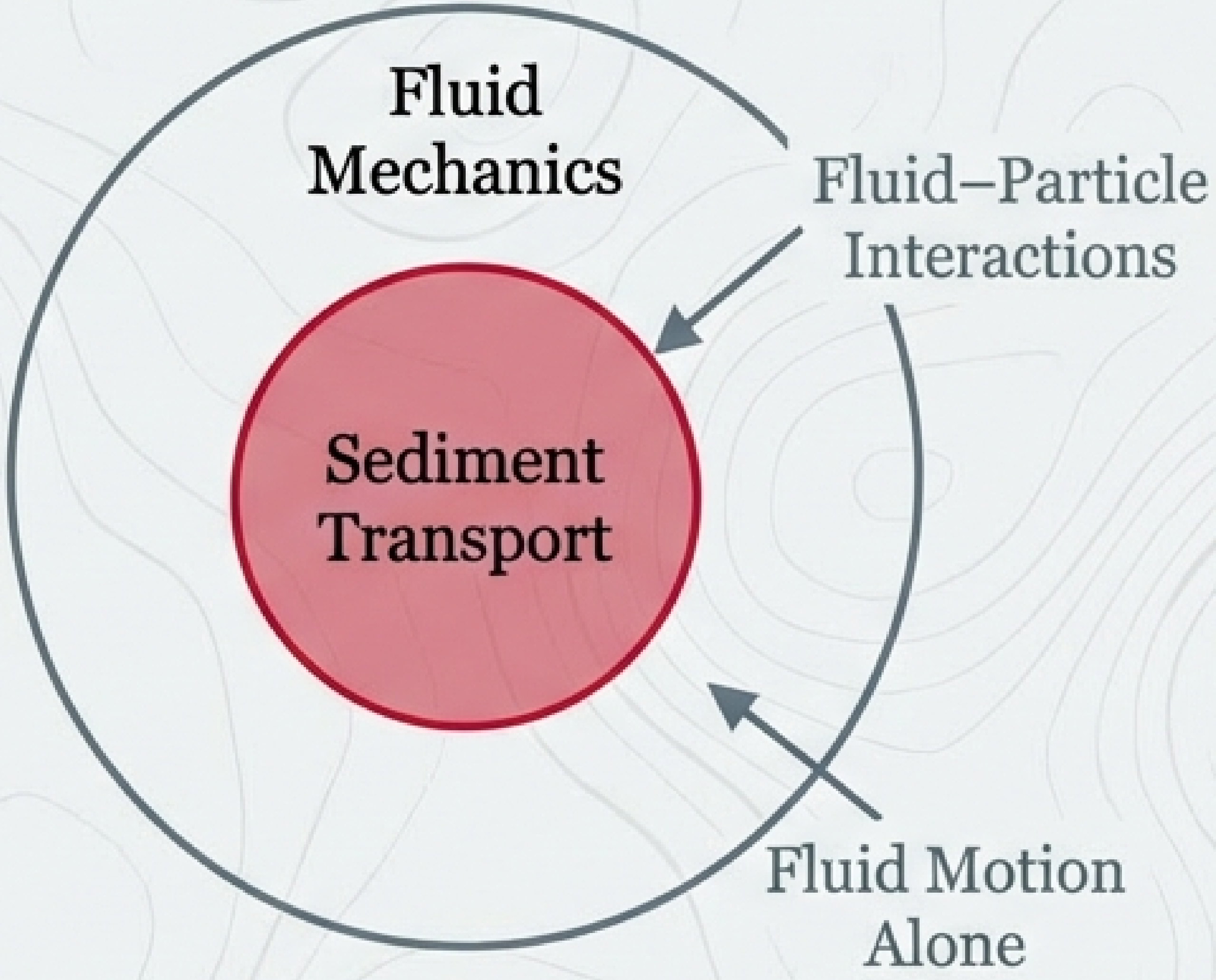
Fundamental Definition

Sediment transport is fundamentally the motion of granular particles driven by a moving fluid.



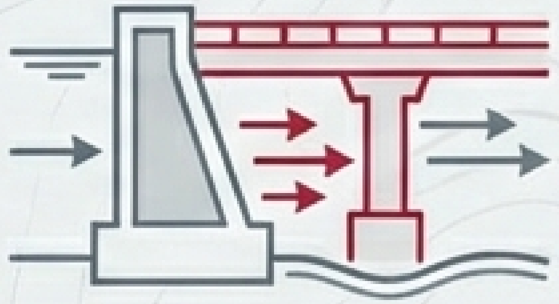
A Specialized Subfield of Fluid Mechanics

Limiting Case:
If Solid Concentration $\rightarrow 0$
Then System = Pure Fluid Flow



This course bridges the gap between pure hydrodynamics and the physical reality of natural granular boundaries.

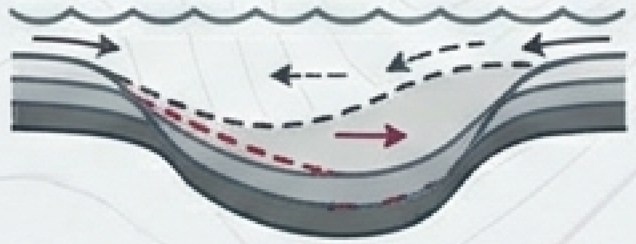
Civil Engineering: The Cycle of Intervention and Response



Stage 1: Flow Modification
Human interventions (dams, bridges, channelization) alter velocity, depth, and turbulence.

Hydrodynamics → Sediment Response → Engineering Consequences

Stage 2: Sediment Response
Changed conditions lead to entrainment, transport, deposition, or erosion.



Stage 3: Morphological Adjustment
Riverbeds evolve through scour, bed lowering, and lateral migration.

Engineering Risks and Infrastructure Stability

Bridge Scour

Localized erosion around piers and abutments; a major risk to structural stability.

Reservoir Sedimentation

Progressive loss of storage capacity and reduced operational lifetime.

River Bed Degradation

Bed lowering affects channel conveyance and flood probability (often post-dam removal).

Navigation Channels

Sedimentation reduces navigability, increasing dredging requirements.

Non-scour Design

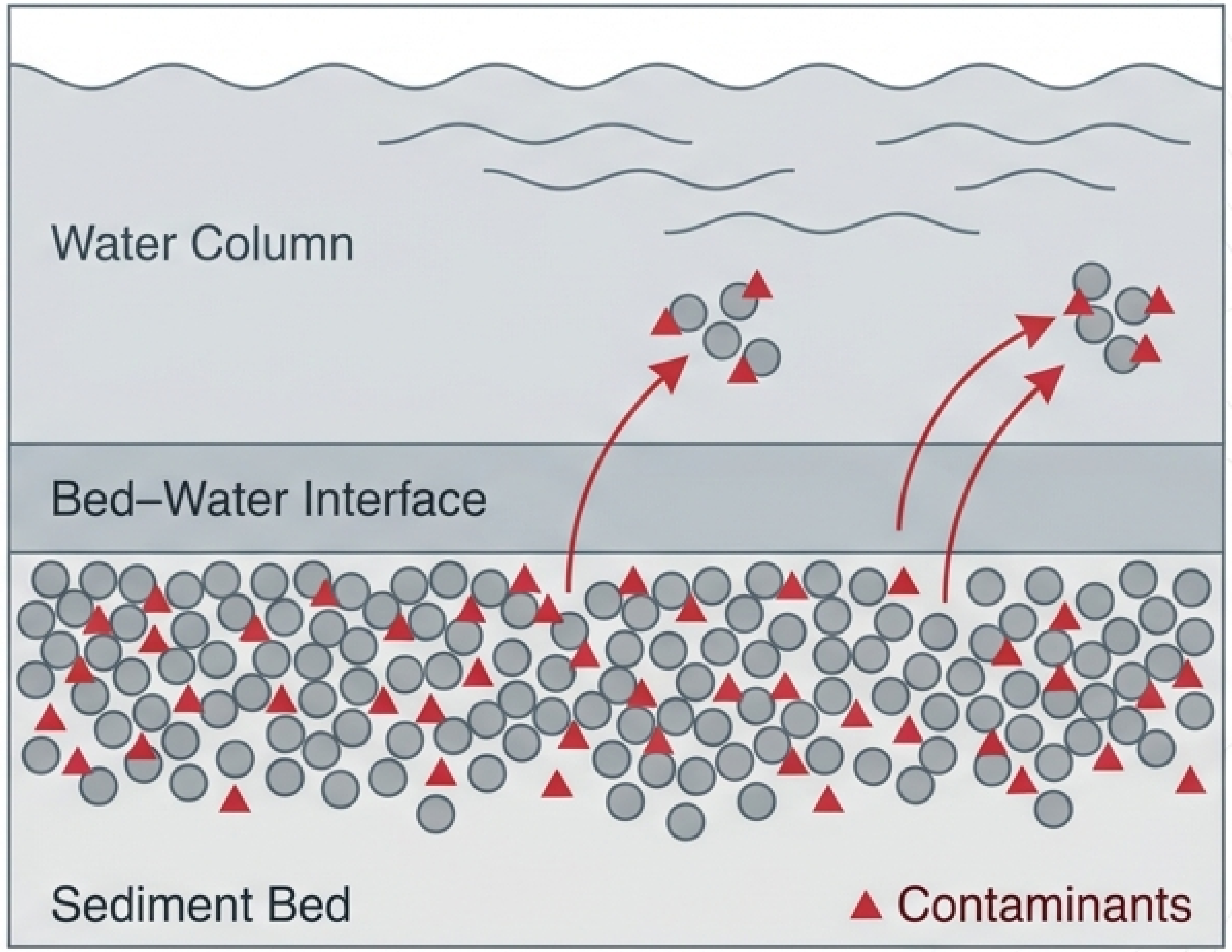
Ensuring stability of beds and banks in canals.

Environmental Impact: The Sediment-Contaminant Interface

Hydrodynamic forcing controls entrainment and resuspension at the bed–water interface.

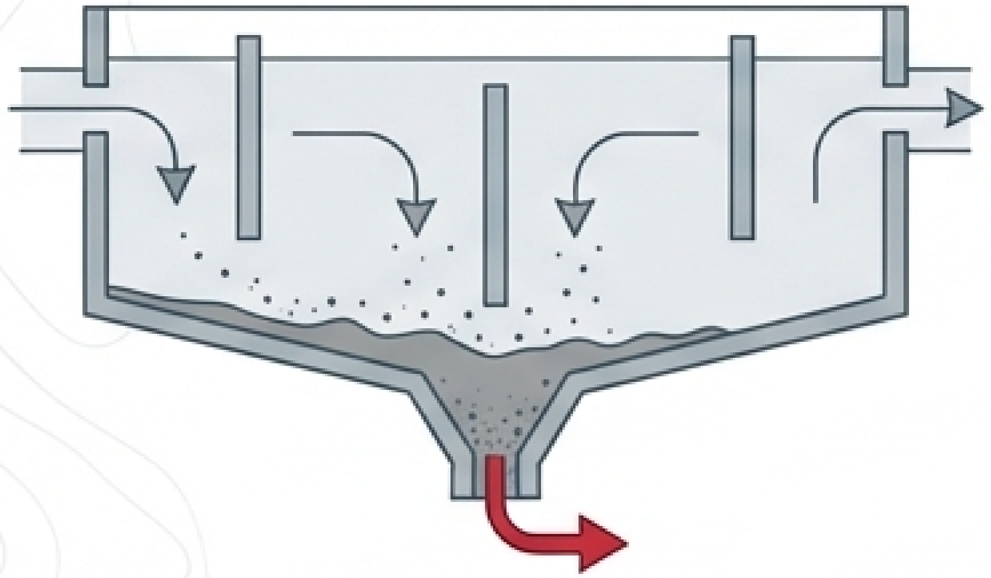
Risks include:

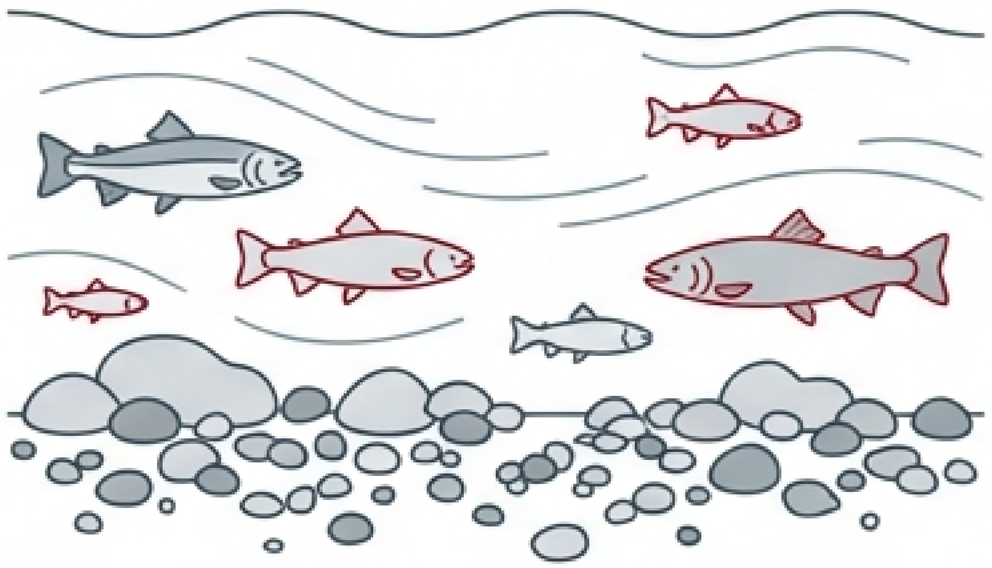
1. **Adsorption**: Toxic substances and nutrients bond to sediment particles.
2. **Transport**: Sediment acts as a vehicle for contaminant migration.
3. **Exchange**: Resuspension releases pollutants back into the water column.

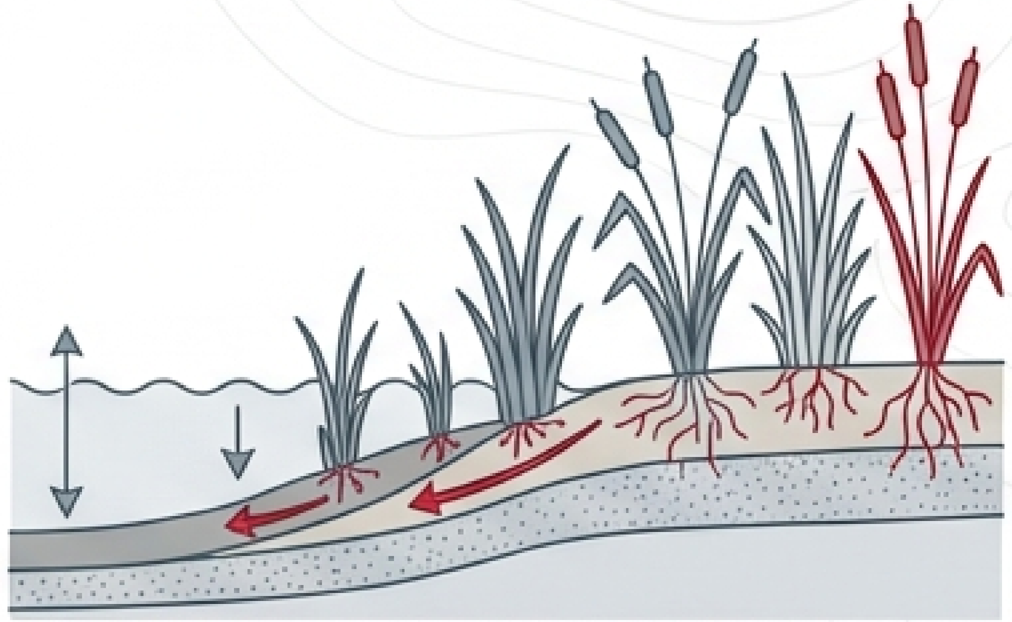


Hydrodynamics → Sediment Processes → Biogeochemical & Ecological Outcomes

Ecological Restoration and Management







Wastewater Treatment

Controlled sedimentation is a physical process used for pollutant removal.

Habitat Protection

Grain size and stability determine the health of benthic communities and spawning grounds.

Wetland Restoration

Sediment supply governs wetland sustainability, elevation maintenance, and resilience.

Goal: Understand sediment pathways to reduce contaminant exposure and support healthy aquatic ecosystems.

Course Roadmap Part I: Fundamentals

- **Introduction**
  (Scope and definitions)
- **Sediment Properties**
  (Physical characteristics)
- **Review of Fluid Mechanics**
  (Hydrodynamic basis)
- **Particle Settling**
  (Mechanics of falling grains)
- **Scour Criteria**
  (Design of stable channels)
- **Alluvial Bed Forms**
  (Flow resistance)

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Course Roadmap Part II: Transport Mechanisms & Modeling

- **Bed Load**
  (Transport along the bottom)
- **Suspended Load**
  (Transport within fluid column)
- **Total Load**
  (Combined analysis)
- **Channel Aggradation/Degradation**
  (Modeling with **HEC-RAS**)
- **Overland Erosion Processes**
  (Sediment generation)

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Course Roadmap Part III: Advanced Applications

Reservoir Sedimentation
(Management and flushing)

Sewer Systems
(Solids deposition in infrastructure)

Cohesive Sediment
(Muds and clays)

Bridge Scour
(Prediction and protection)

Dam Removal
(Stream restoration dynamics)

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Key Reference Texts

** Available on reserve or via E-book at Rutgers Library*

- **Sediment Transport Dynamics**, W. Wu (2023) [E-book]*
- **Sediment Transport: Theory and Practice**, C. T. Yang (1996) [Reserve]*
- **Fluvial Processes in River Engineering**, H. H. Chang (1992) [Reserve]*
- **Sediment Transport Technology**, Simons & Sentürk (1992) [Reserve]*
- **Stream Restoration in Dynamic Fluvial Systems**, Simon et al. (2011) [Reserve]*

Course Logistics

Schedule & Location

Wednesdays, 6:00 - 9:00 PM

Busch Campus, Weeks Hall 402

Instructor Contact

Dr. Q. Guo

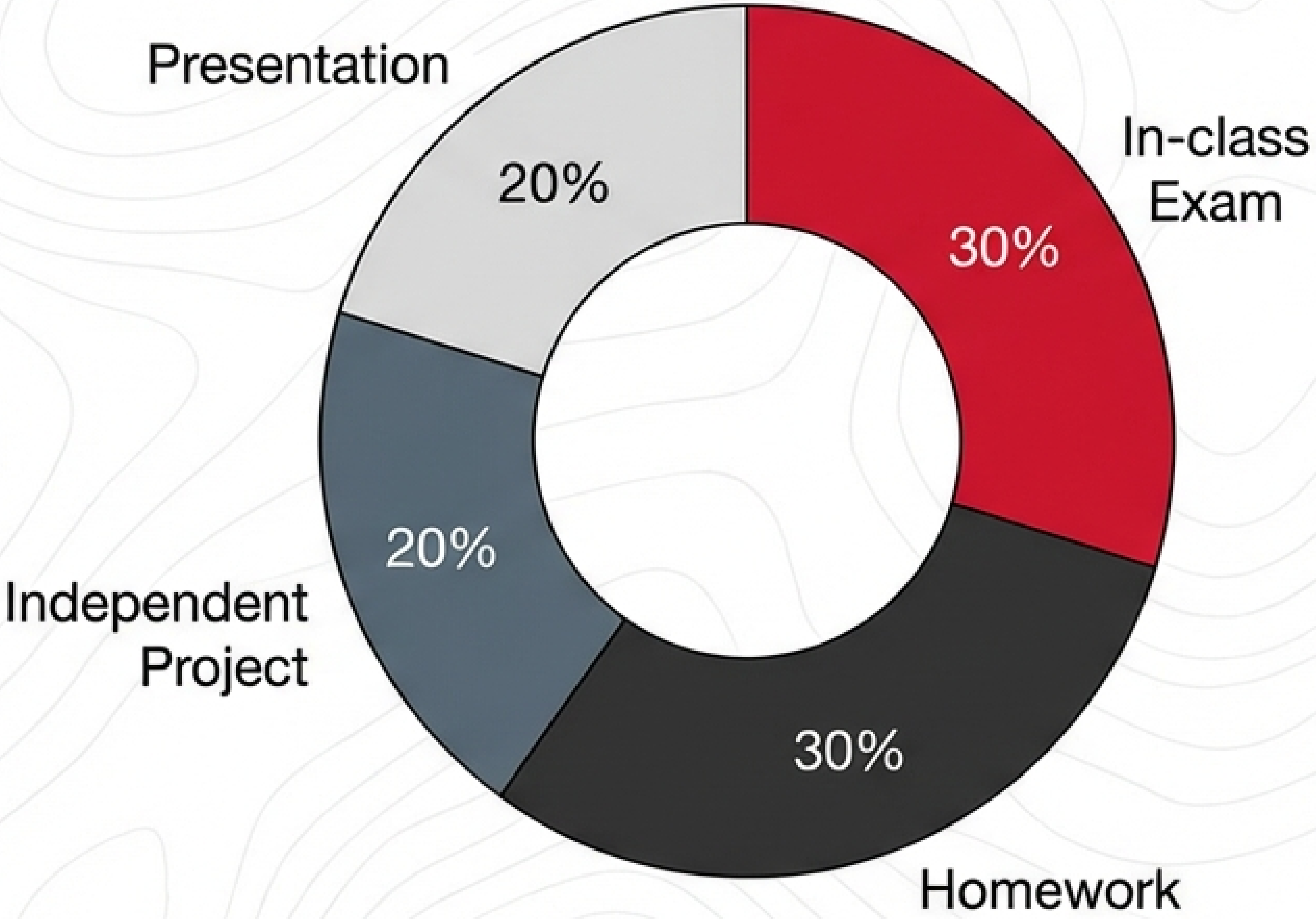
Phone: (848) 445-2983

Email: Qguo@rutgers.edu

Office: Weeks Suite 328

Hours: By appointment

Grading & Assessment



Homework:	30%
In-class Exam:	30%
Presentation:	20%
Independent Project:	20%

The Integrated Management Objective

Core Mission:
To predict, control, and mitigate sediment-related risks through integrated hydraulic and environmental planning.

Ultimate Goal:
Improve water quality, ensure infrastructure safety, and support healthy aquatic ecosystems in a changing environment.