

## Potential Effect of Boat Wakes on the Willamette River Margins

Dr. Pedro Lomonaco and Prof. Solomon Yim



March 3<sup>rd</sup>, 2021

# Potential Effect of Boat Wakes on the Willamette River Margins

## Outline

- Introduction
- Boat Wake Generation and Propagation
- River Margin Morphodynamics
- Problem Assessment

Newberg Pool



Wilsonville



# Potential Effect of Boat Wakes on the Willamette River Margins

## Introduction

- **Erosion has been observed along the Willamette River margins**, and it has been generally associated with the navigation (leisure) activity.
- **Erosion has been observed for several years**, and apparently it has increased recently, since the introduction of wakeboarding and wakesurfing.
- **Other sources of erosion**, including the natural evolution of the river morphology, have been also proposed as responsible of the problem.
- We will first address the characteristics and description of water surface boat wakes



# Potential Effect of Boat Wakes on the Willamette River Margins

## Boat Wake Generation and Propagation

Wakes are the wave pattern on the water surface downstream of an object in a flow, or produced by a moving object.

Boat Wakes can be described by:

Height, Period, Energy Flux, Direction

Boat Wakes are affected by:

Boat speed, length, draft, shape, propulsion method

Water depth, current, dispersion, dissipation



# Potential Effect of Boat Wakes on the Willamette River Margins

Observations along the Willamette River Margins

Natural and built environment





## Potential Effect of Boat Wakes on the Willamette River Margins

Observations along the Willamette River Margins

Bed material (mud, sand, gravel, pebbles, cobbles, rock)





# Potential Effect of Boat Wakes on the Willamette River Margins

Observations along the Willamette River Margins

Margin vegetation and trees





# Potential Effect of Boat Wakes on the Willamette River Margins

Observations along the Willamette River Margins

Shoreline protection (wooden piles, rock, armor stones)





# Potential Effect of Boat Wakes on the Willamette River Margins

Observations along the Willamette River Margins

Development (docks, piers, pontoons, ramps, houses, buildings, bridges, abutments, dams)



# Potential Effect of Boat Wakes on the Willamette River Margins

## Observations along the Willamette River Margins

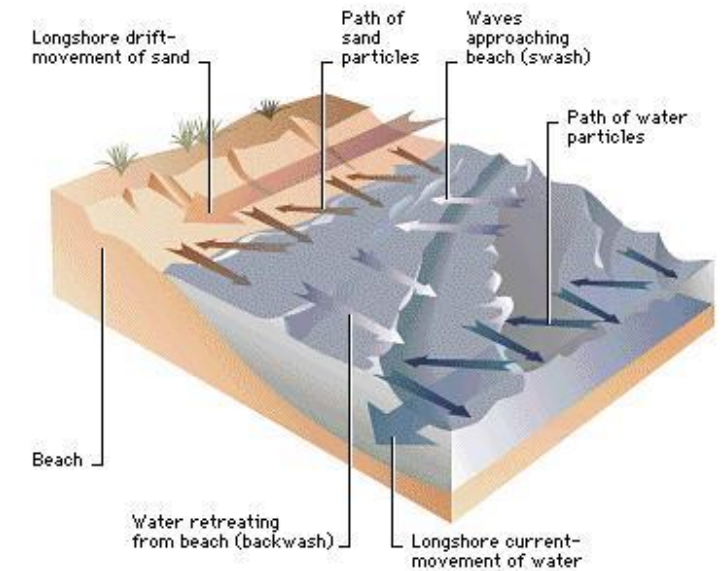
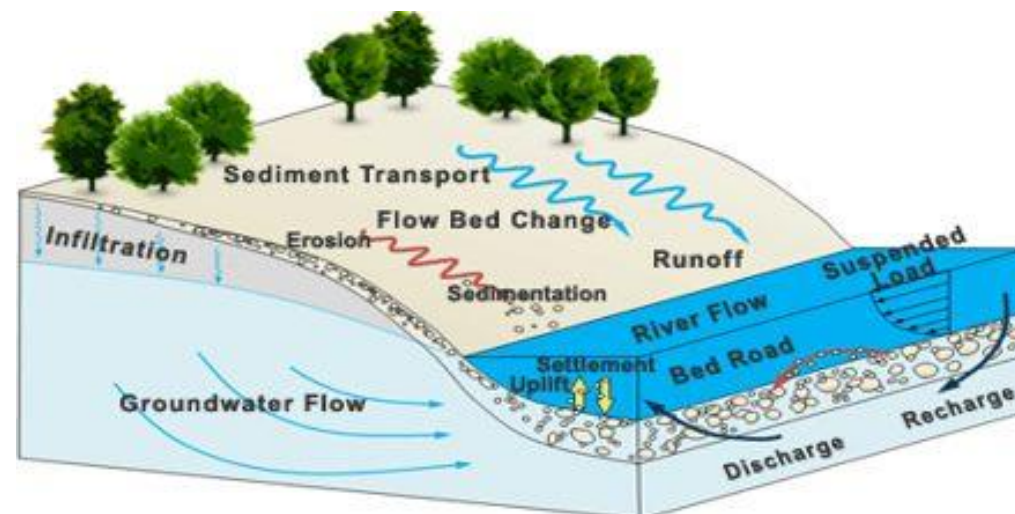
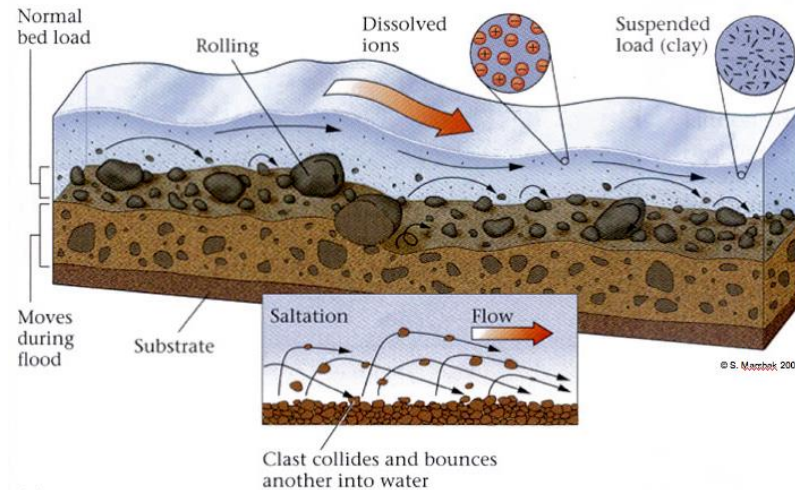
Development (docks, piers, pontoons, ramps, houses, buildings, bridges, abutments, dams)



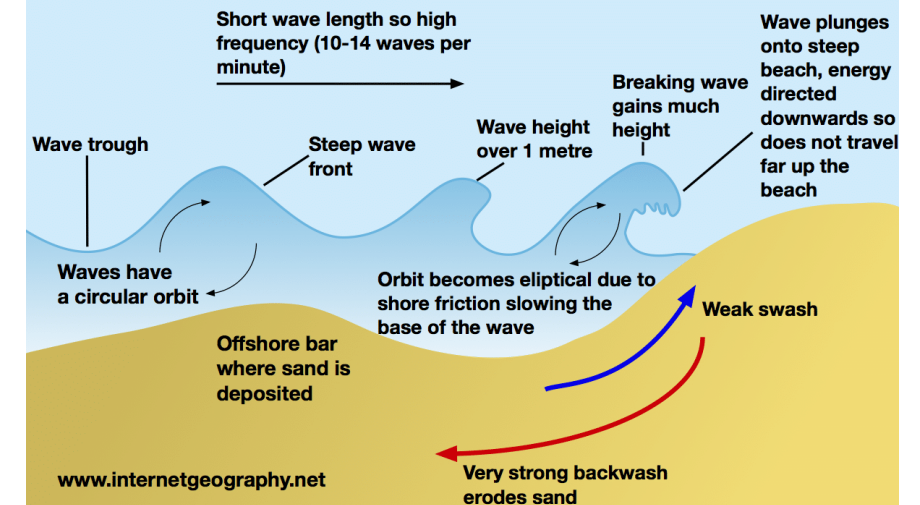


# Potential Effect of Boat Wakes on the Willamette River Margins

## Problem Assessment: Sediment transport process



## Destructive Wave



# Potential Effect of Boat Wakes on the Willamette River Margins

## Problem Assessment

- **Erosion has been observed** along the Willamette River margins, and it has been generally associated with the navigation (leisure) activity.
- **Any object** interfering with the water flow, or moving in the fluid **will generate wakes**. Boat wakes are one of the forms of the waves produced by this interaction.
- Displacement (transport) of loose material (sediment, rocks, or any object) in rivers is function of the water particle velocities and pore pressures.
- **Different time and length scales** are observed in sediment transport processes. Natural processes at mid-scales (order of hundreds of yards to few miles) are associated to relatively long-term scales (order of several years), with the exception of episodic extreme events.
- It can be said that, within the corresponding time scale, a sedimentary system will tend, naturally, to a **dynamic equilibrium** as long as the hydrodynamic conditions are **not changed** significantly.
- These (natural) conditions have not changed (significantly) since the end of the last ice age (~15,000 years).



# Potential Effect of Boat Wakes on the Willamette River Margins

## Problem Assessment

- Intensive anthropogenic activity have changed the morphodynamic conditions along the Willamette River (since ~1850?):
  - Agriculture
  - Construction
  - Excavation
  - Dams
  - Reclamation
  - Dredging
  - Water intakes
  - Industrial Discharges
  - Tourism and Leisure Activities
  - Watersports
  - Climate change
  - ...
- Each of the different activities have varying intensities and time responses.

# Potential Effect of Boat Wakes on the Willamette River Margins

## Problem Assessment

- **Erosion will occur**, only, if there is an **imbalance** of the sediment budget.
- The most relevant natural morphodynamic effect at the location of interest are:
  - Sedimentation, produced by reduced current intensities due to the Willamette Falls Dam, located downstream
  - Erosion on outer margins and accretion on inner margins of meanders
  - Vegetation and rocky outcrops prevent or reduce erosion
  - Vegetation induces sedimentation and produce biomass
  - Dynamics have low intensity, but are continuous and steady
- The most relevant anthropogenic effect at the location of interest are:
  - Artificial alteration and control of the river flow by the Willamette Falls Dam
  - Generation, propagation, and incidence of **boat wakes** along the shorelines
  - Dynamics of boat wakes have high intensity, but are discontinuous and variable.



# Potential Effect of Boat Wakes on the Willamette River Margins

## Problem Assessment

- **Boat wakes**, as any other disturbance, produce an imbalance in the sediment transport and, therefore, may induce **scour and erosion**.
- Significant erosion due to boat wakes can be explained by the cumulative effect of large number of waves, over long time, multiannual, similar to the one observed by natural evolution.
- **Differentiate** the natural evolution, dynamic equilibrium, long-term anthropogenic disturbance, and short-term effects is not an easy task.
- The **scale and complexity** of the problem prevents to have a single, definitive answer.
- Economy, social perception, history, education, policies, and other elements play a significant role in the assessment of the potential effect of boat wakes on the Willamette River Margins.

# Potential Effect of Boat Wakes on the Willamette River Margins

## Problem Assessment

Summary of governing parameters affecting erosion along the margins

Natural parameters (steady component)	Navigation parameters (dynamic component)
Width of the river Depth (water level) Current speed Curvature of the river Cross-sectional variation Bed material Sediment input Debris Vegetation Variation in the flowrate Alongshore elements (floating docks) Seasonal variations Time-scale	Boat-type Boat speed Displacement Boat length Propulsion system Hull form Navigation depth Navigation path Number of boats (frequency of occurrence) Time-scale