# Open Channel Flow

# Basic Equations

- Conservation of Mass
- Conservation of Linear Momentum
- Conservation of Energy

# Conservation of Mass
# (Continuity Equation)

Mass flux into the system - Mass flux out of the system

= Time rate of change in mass in the control volume

$$A_1V_1 = A_2V_2 = Q$$

# Conservation of Linear Momentum

Flux of momentum out of the control volume – Flux of momentum into the control volume + Time rate of change of momentum in the control volume = Sum of the forces acting on the fluid in the control volume

$$\rho Q(\beta_2 V_2 - \beta_1 V_1) = \sum F_x$$

# Conservation of Energy
# Bernoulli Equation

Flux of energy out of the control volume – Flux of energy into the control volume + Time rate of change of energy in the control volume = Rate at which heat is added to a fluid system – the rate at which a fluid system does work on its surroundings

$$\frac{V_1^2}{2g} + \frac{P_1}{\gamma} + Z_1 = \frac{V_2^2}{2g} + \frac{P_2}{\gamma} + Z_2 = constant$$

# St. Venant Equations

- Continuity Equation

$$v\frac{\partial A}{\partial x} + A\frac{\partial v}{\partial x} + b\frac{\partial h}{\partial t} = 0$$

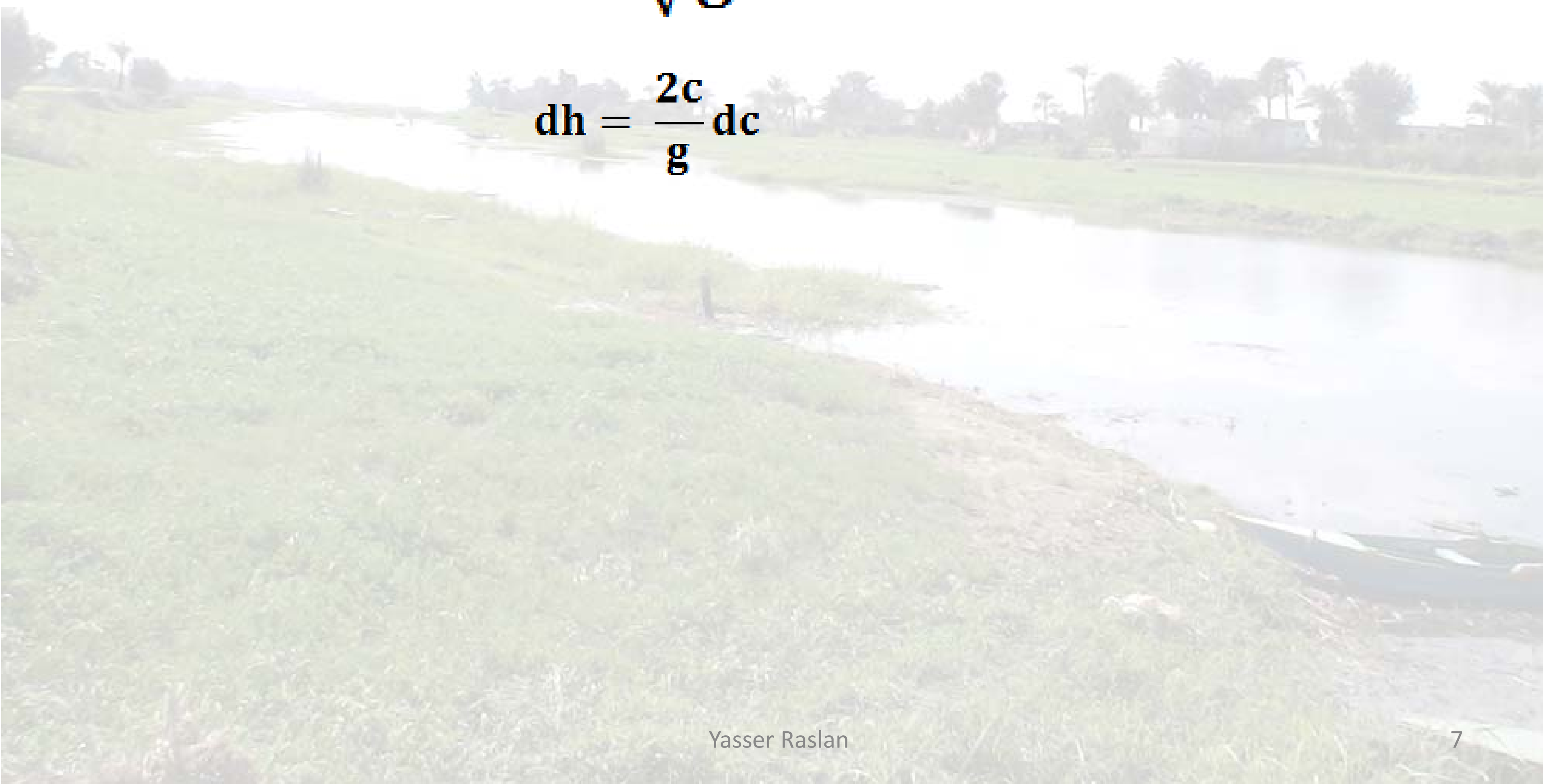
- Momentum Equation

$$g\frac{\partial h}{\partial x} + v\frac{\partial v}{\partial x} + \frac{\partial v}{\partial t} = g(S_i - S_e)$$

# Chezy

$$C = \sqrt{gh}$$

$$dh = \frac{2c}{g} dc$$



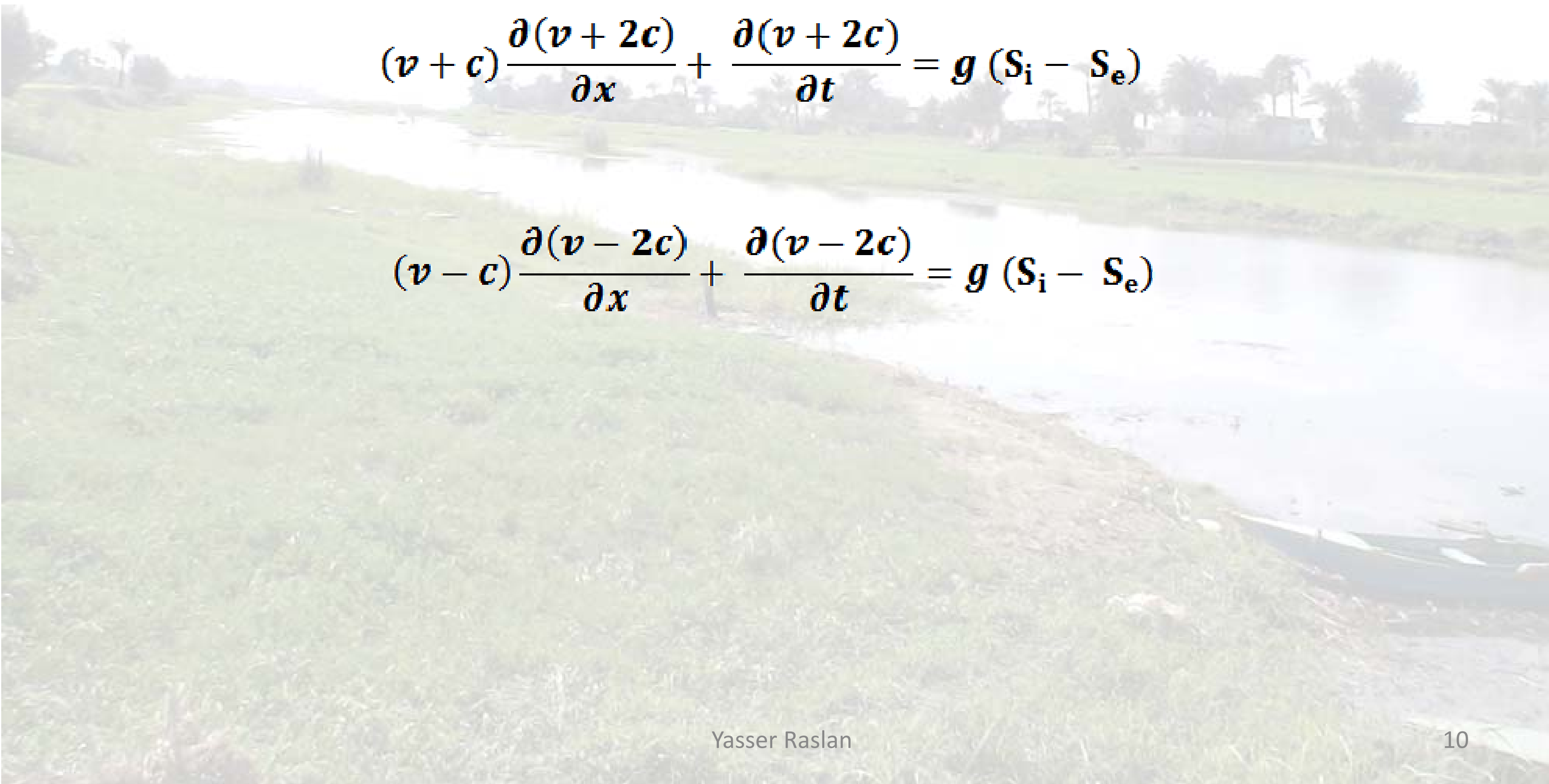
# From Continuity Equation  $A = bh$

$$2v\frac{\partial c}{\partial x} + c\frac{\partial v}{\partial x} + 2\frac{\partial c}{\partial t} = 0$$

- From the momentum equation

$$2c\frac{\partial c}{\partial x} + v\frac{\partial v}{\partial x} + \frac{\partial v}{\partial t} = g(S_i - S_e)$$

# Adding the energy and momentum equations and subtracting them



$$(v+c)\frac{\partial(v+2c)}{\partial x}+\frac{\partial(v+2c)}{\partial t}=g\,(S_i-S_e)$$

$$(v-c)\frac{\partial(v-2c)}{\partial x}+\frac{\partial(v-2c)}{\partial t}=g\,(S_i-S_e)$$

# St. Venant Equations

$$\frac{d(v+2c)}{dt} = g\ (S_i - \ S_e)$$

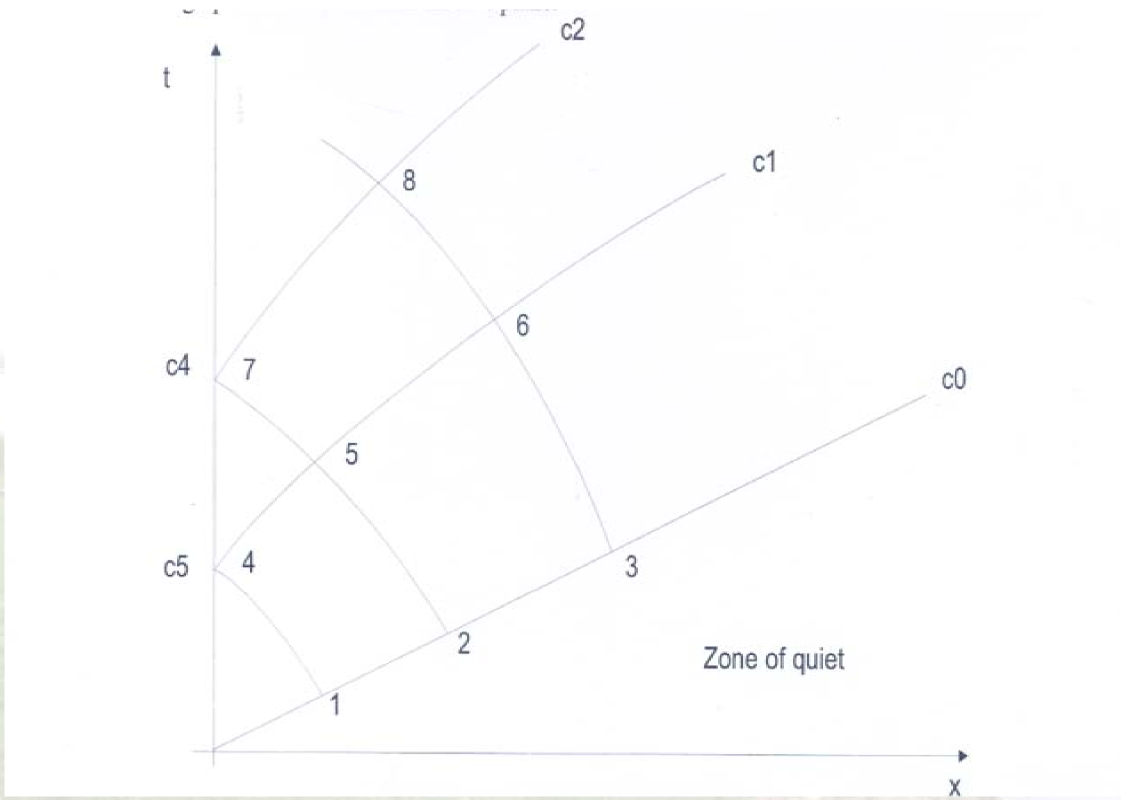
For

$$\frac{dx}{dt} = (v+c)$$

$$\frac{d(v-2c)}{dt} = g\ (S_i - \ S_e)$$

For

$$\frac{dx}{dt} = (v-c)$$


c2
t
8
c1
6
c4
7
c0
5
c5
4
3
2
Zone of quiet
1
x