**Associazione Idrotecnica Italiana**

Torino, 16 Gennaio 2015

# "Recenti acquisizioni idrodinamiche e campi di moto nelle scale di risalita dei pesci"

Dott.sa Marini Irene

# Obiettivi e finalità

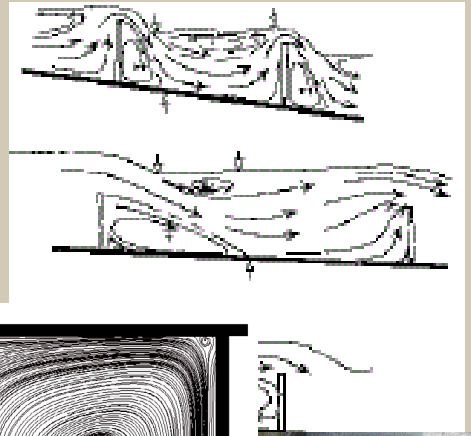
- Conoscenze di base

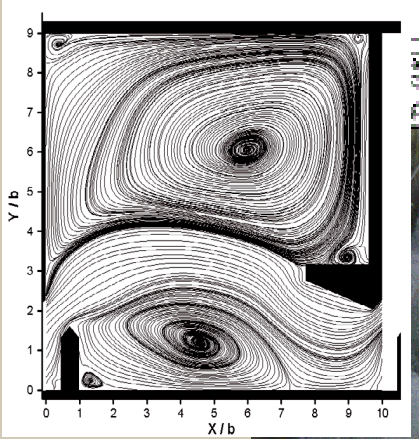
- Campagne di misura in sito
  - **Casalgrasso**
  - **Soana**
  - **Meano**
  - **La Loggia**

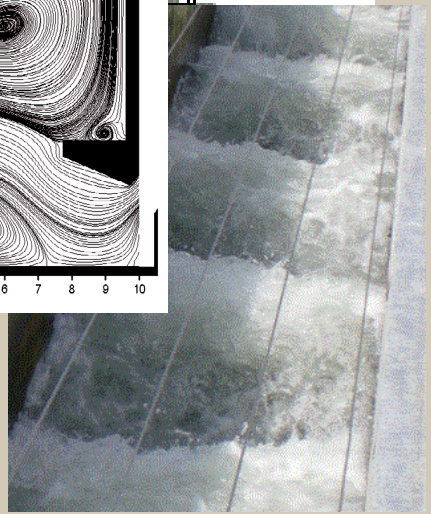
- Analisi dei flussi
- Verifica funzionalità
- Verifica formule teoriche di dimensionamento

# Generalità

- PROBLEMA MULTIDISCIPLINARE
- FENOMENI IDRODINAMICI COMPLESSI





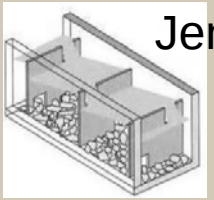
- Flussi
- Turbolenza
- Formule di dimensionamento

VERIFICHE SPERIMENTALI

# Il lavoro svolto

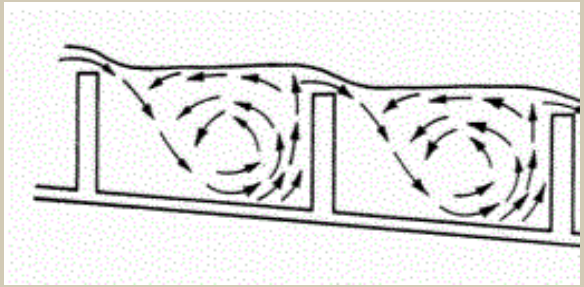
- ANALISI DEI FLUSSI
  - Studi disponibili in letteratura
  - Attività di analisi sperimentale
  - Confronto tra i casi studio e i modelli teorici
  - Verifica funzionalità siti esaminati
- VERIFICA FORMULE UTILIZZATE PER IL DIMENSIONAMENTO

# Pool and weir



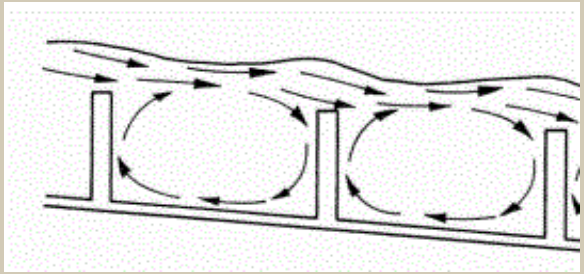
Jens (1982)

- "Plunging flow"

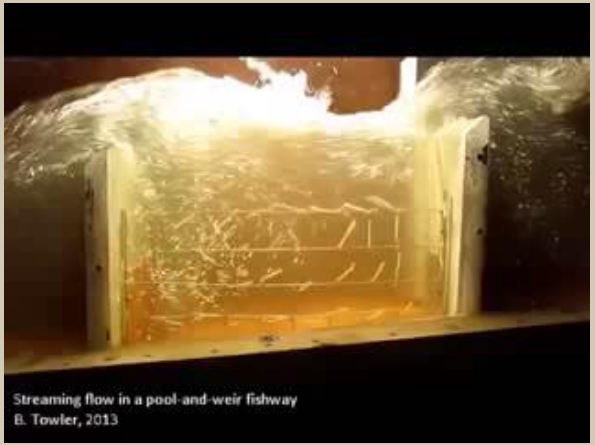


(Clay, 1961)

- "Streaming flow"

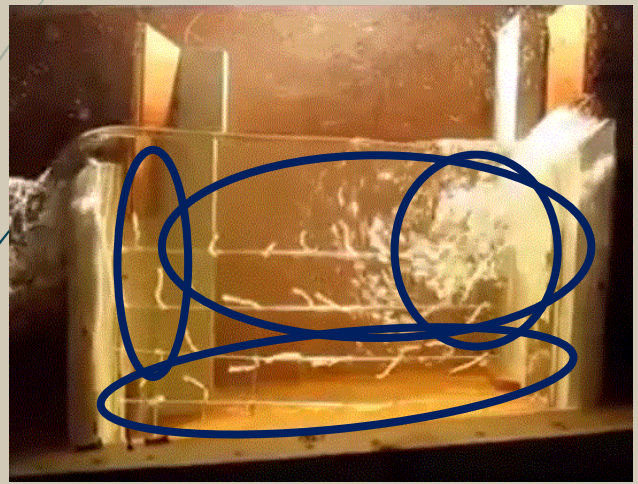


(Clay, 1961)

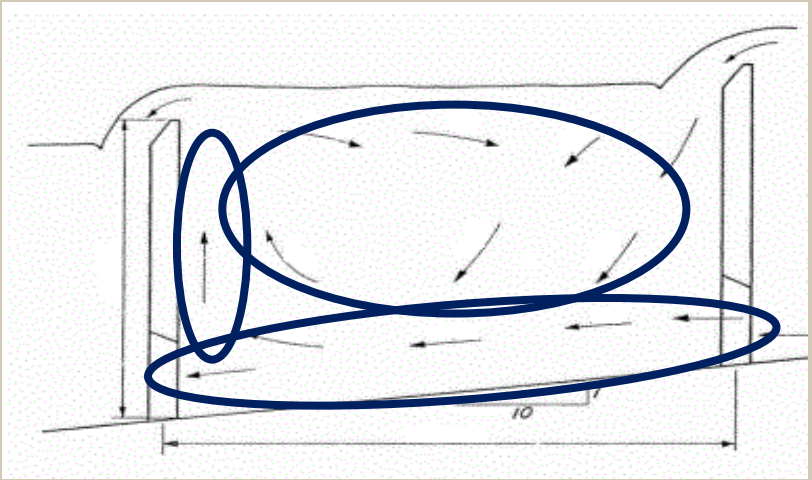


# Pool and weir

- "Plunging flow"



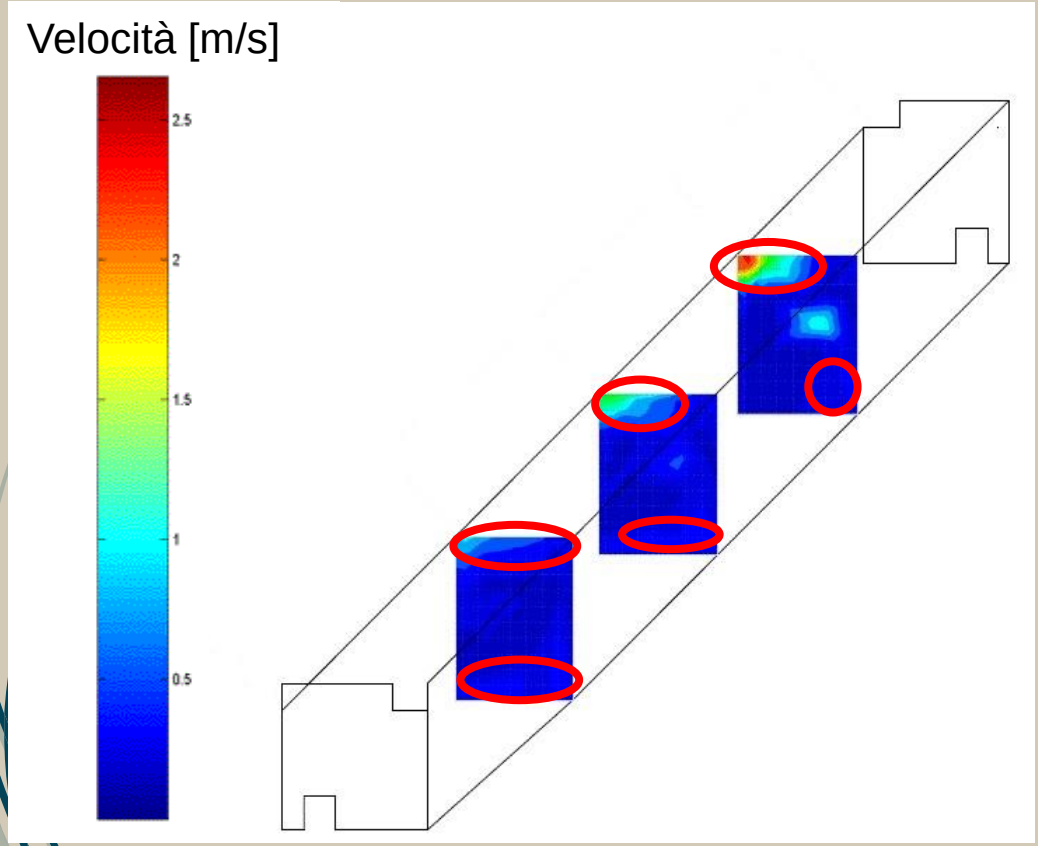
(B. Towler, 2013)

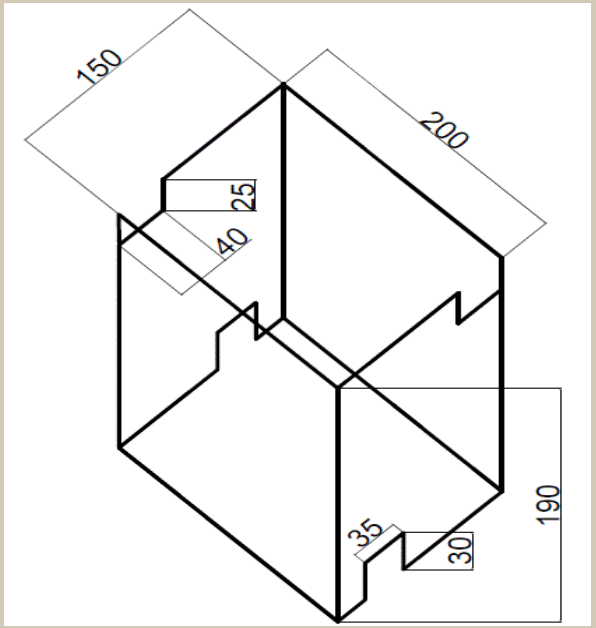



(Elling e Raymond, 1956)

- A regime

# Casalgrasso

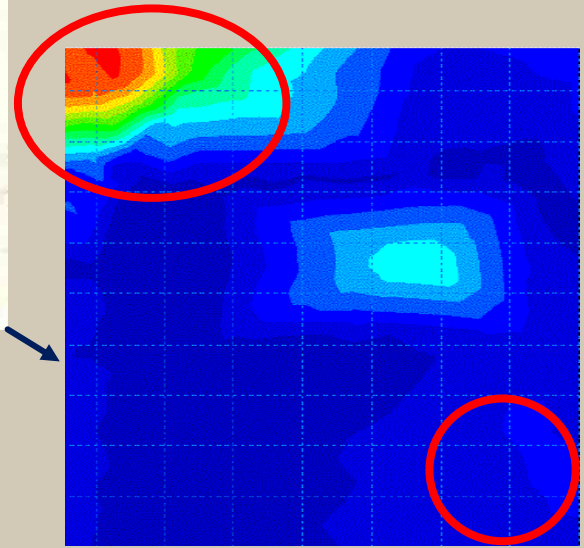



| | |
|---|---|
| $Q_{misura}$ [m³/s] | 0,473 |
| $Q_{progetto}$ [m³/s] | 0,550 |

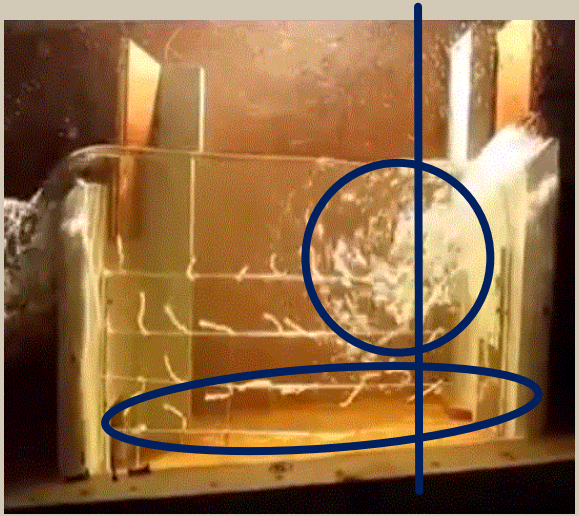
# Casalgrasso

| | |
|---|---|
| $Q_{misura}$ [$m^3/s$] | 0,473 |
| $Q_{progetto}$ [$m^3/s$] | 0,550 |



Sezione di monte

Ubicazione sezione



(B. Towler, 2013)

# Casalgrasso

| $Q_{misura}$ [m³/s] | 0,473 |
|---|---|
| $Q_{progetto}$ [m³/s] | 0,550 |

$$P_v = \rho \cdot g \cdot Q \cdot \frac{\Delta h}{V}$$ = Potenza volumetrica dissipata

ρ = densità [kg/m³]

g = accelerazione di gravità [m/s²]

Q = portata [m³/s]

Δh = dislivello [m]

V = volume[m³]

| **Q [m³/s]** | 0,25 | |
|---|---|---|
| **V [m³]** | 5,96 | |
| **Δh [m]** | 0,25 | |
| **$P_v$ [W/m³]** | **102,0** | **<150 [W/m³]** |

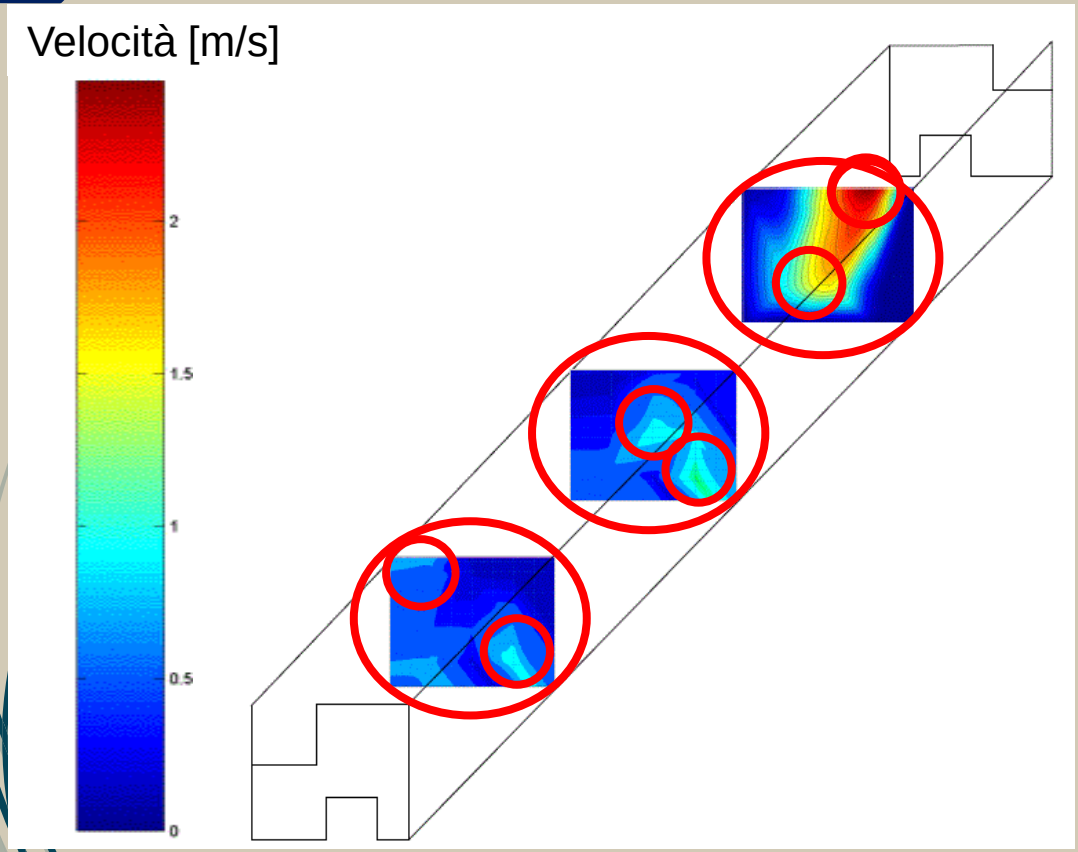
# Casalgrasso

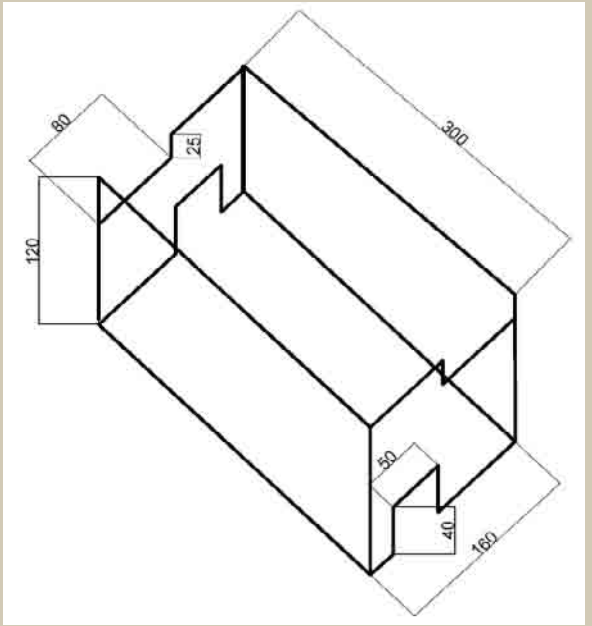
| | |
|---|---|
| $Q_{misura}$ [m³/s] | 0,888 |
| $Q_{progetto}$ [m³/s] | 0,550 |

(B. Towler, 2013)

(B. Towler, 2013)

# Soana

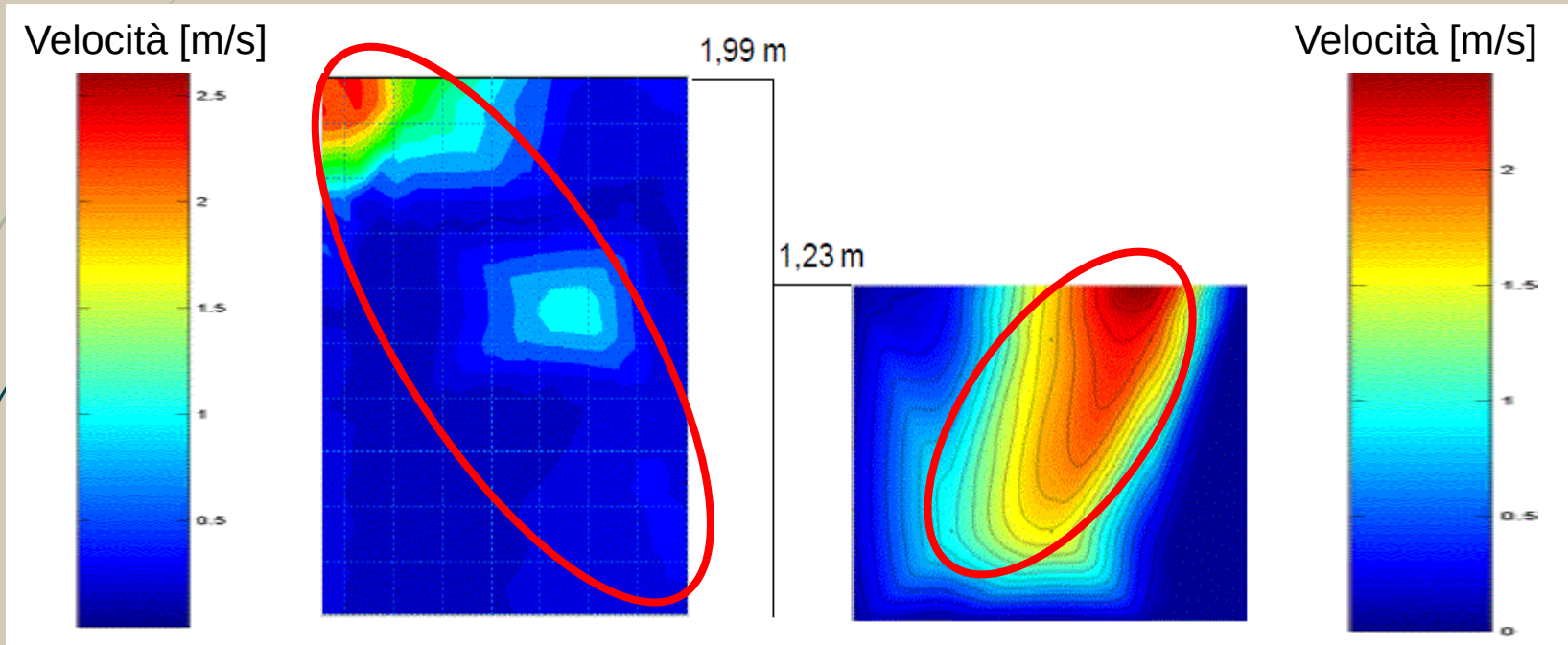



| | |
|---|---|
| $Q_{stimata}$ [m³/s] | 0,770 |
| $Q_{progetto}$ [m³/s] | 0,650 |

# Confronto Casalgrasso/Soana

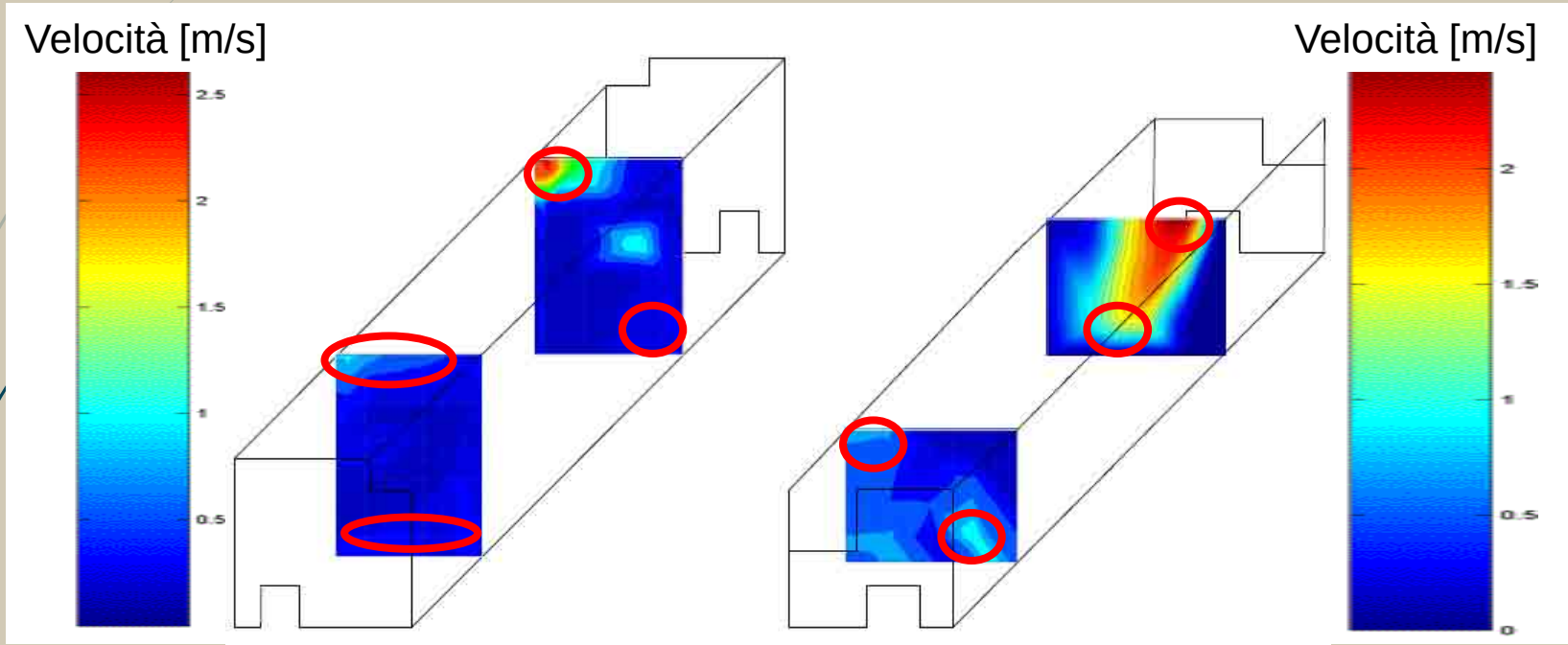
Sezione di monte




Casalgrasso

Soana

# Confronto Casalgrasso/Soana

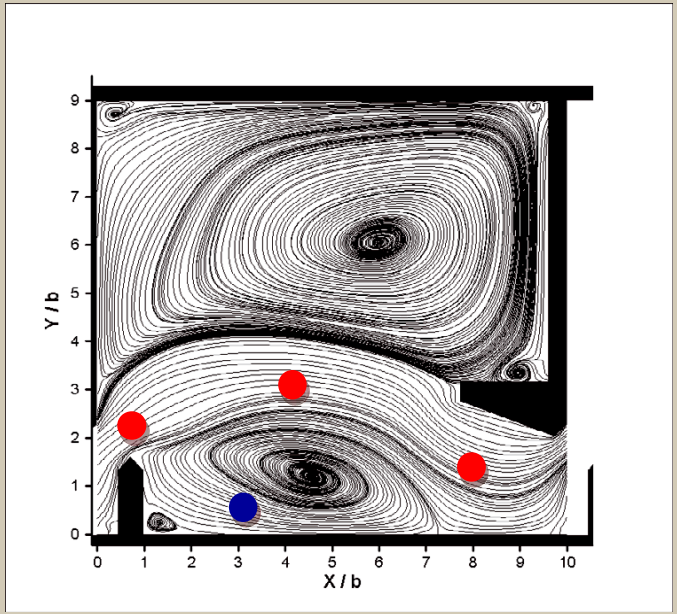



Casalgrasso

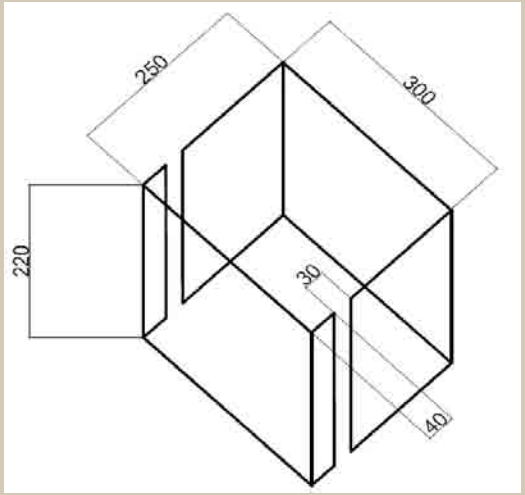
Soana

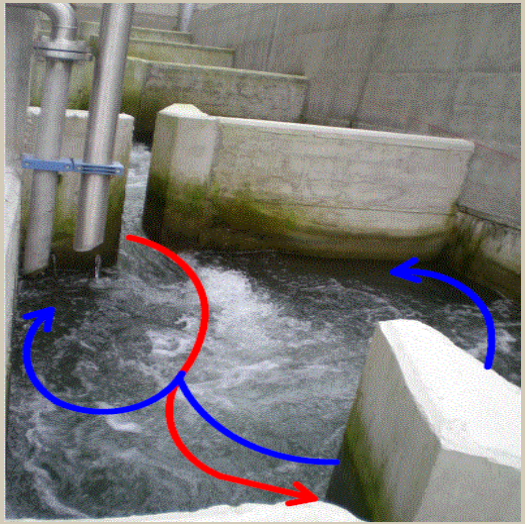
# La Loggia

| | |
|---|---|
| $Q_{misura}$ [m³/s] | 0,734 |
| $Q_{progetto}$ [m³/s] | 0,790 |

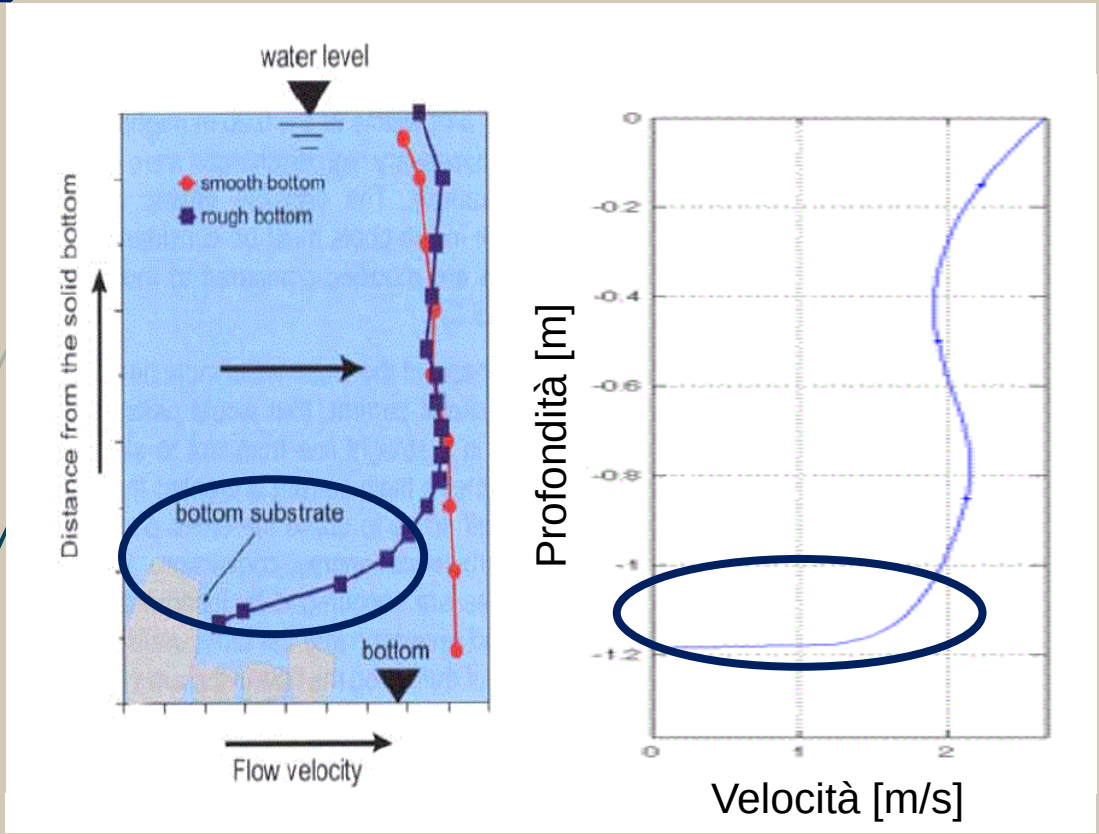



Wang et al. (2010)



# La Loggia




Gebler (2002)

| | |
|---|---|
| **Q [m³/s]** | 0,73 |
| **V [m³]** | 9,59 |
| **Δh [m]** | 0,25 |
| **$P_v$ [W/m³]** | **187,4** |

$$P_v = \rho \cdot g \cdot Q \cdot \frac{\Delta h}{V}$$

**$P_v$ [W/m³] > 150 [W/m³]**

# Verifica formule teoriche di dimensionamento

- *“(…) Le suddette formulazioni sono basate su studi di laboratorio e misure effettuate in condizioni indisturbate e quindi la relativa precisione andrà verificata in sede di realizzazione del passaggio; tra i fattori critici che possono influenzarne la precisione vi è sicuramente la scelta del coefficiente di deflusso $C_d$ da utilizzare. (…)"*

***Cit.*** Regione Piemonte, Settore Tutela e Gestione della Fauna Selvatica e Acquatica, *“Manuale regionale – Linee guida per la progettazione e la verifica dei passaggi per i pesci”*, 2006

# Pool and weir

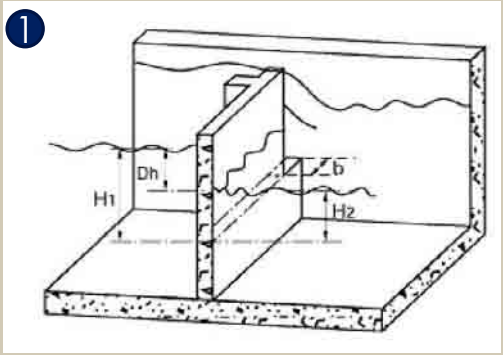
❶ $$Q = k \cdot Q_d$$

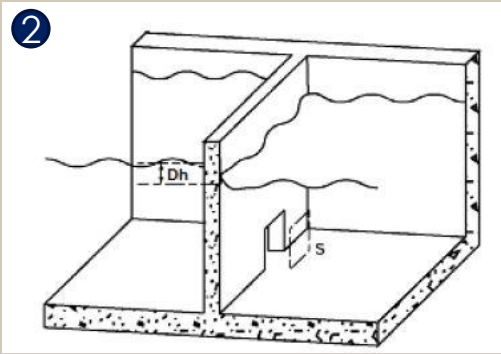
$$k = \left[1 - \left(1 - \frac{\Delta h}{H_1}\right)^{1,5}\right]^{0,385}$$

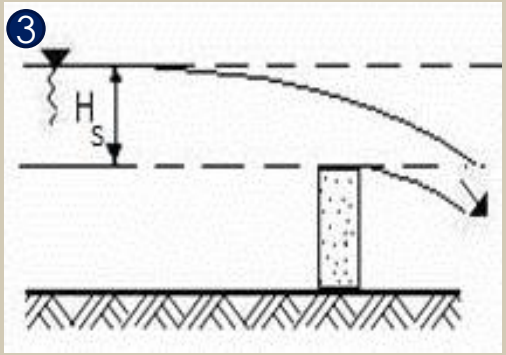
$$Q_d = C_d \cdot b \cdot \sqrt{2 \cdot g} \cdot H_1^{1,5}$$

❷ $$Q = C_d \cdot S \cdot \sqrt{2 \cdot g \cdot \Delta h}$$

❸ $$Q = \mu \cdot B_{sfioro} \cdot \sqrt{2 \cdot g} \cdot H_s^{3/2}$$



# Pool and weir

| [m³/s] | Casalgrasso 1 | Casalgrasso 2 | Meano |
|---|---|---|---|
| $Q_{gaveta}$ | 0,13 | 0,18 | 0,11 |
| $Q_{luce,sottob.}$ | 0,15 | 0,15 | 0,16 |
| $Q_{sfioro}$ | 0,05 | 0,15 | 0,02 |
| **$Q_{calcolo}$** | **0,330** | **0,484** | **0,285** |
| **$Q_{misura}$** | **0,473** | **0,888** | **0,501** |
| **$Q_{mis}/Q_{calc}$ [/]** | **1,43** | **1,83** | **1,76** |

# Pool and weir

**Ipotesi:**

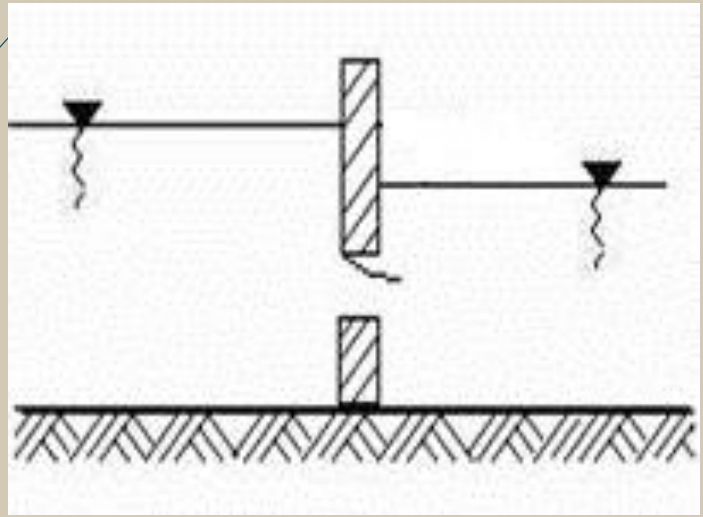
Stramazzi → termine cinetico

# Pool and weir

**Ipotesi:**

Stramazzi → termine cinetico

Foro di fondo → luce in parete grossa rigurgitata → $c_d$



B. Towler (2013)

# Pool and weir

✓ Plunging flow
✓ A regime

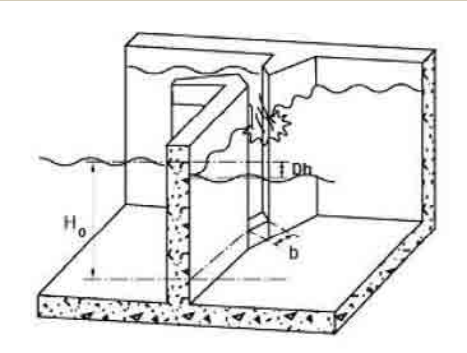
x Plunging flow
✓ A regime

✓ Plunging flow
x A regime

| [$m^3/s$] | Casalgrasso 1 | Casalgrasso 2 | Meano |
|---|---|---|---|
| $Q_{gaveta}$ | 0,15 | 0,21 | 0,13 |
| $Q_{luce,sottob.}$ | 0,18 | 0,18 | 0,18 |
| $Q_{sfioro}$ | 0,09 | 0,23 | 0,06 |
| **$Q_{calcolo}$** | **0,426** | **0,614** | **0,374** |
| **$Q_{misura}$** | **0,473** | **0,888** | **0,501** |
| **$Q_{misura}/Q_{calcolo}$ [/]** | **1,11** | **1,45** | **1,34** |

# Vertical slot

- $Q = C_d \cdot b \cdot H_0 \cdot \sqrt{2 \cdot g \cdot \Delta h}$

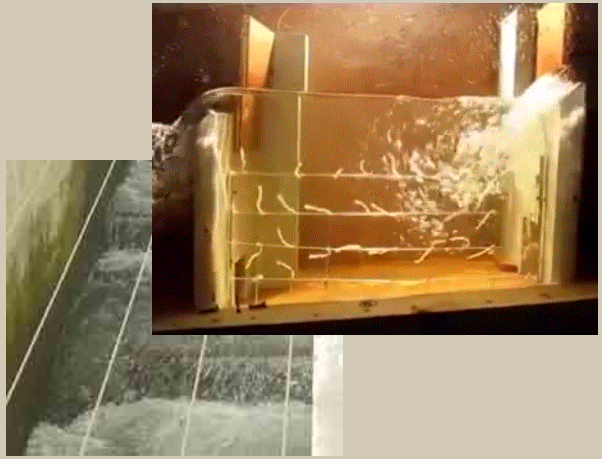


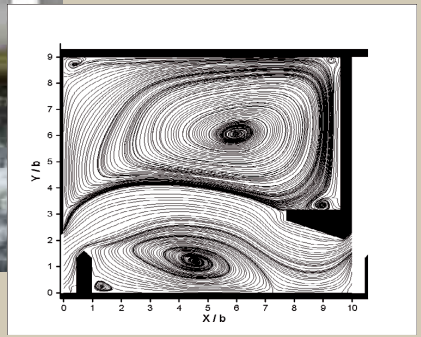

| | Valore di progetto | Valore misurato |
|---|---|---|
| **Q [m³/s]** | 0,790 | 0,734 |
| **$H_0$ [m]** | 1,70 | 1,28 |
| **v [m/s]** | 1,55 | 2,09 |

| | |
|---|---|
| $c_d$ [/] | 0,85 |
| b [m] | 0,30 |
| $H_0$ [m] | 1,28 |
| ΔH [m] | 0,25 |
| **$Q_{tot}$ [m³/s]** | **0,722** |
| **$Q_{misura}$ [m³/s]** | **0,734** |

# Conclusioni

- Fenomeno idrodinamico complesso
- Problematiche
  - Funzionalità
  - Dimensionamento
- Attività e studi futuri





# Grazie per l'attenzione