



# Sediment management in channel networks: from measurements to best practices

## Esperienze e rete di monitoraggio del trasporto solido in Alto Adige

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unibz, 9 novembre 2018



# Sommario

## Outline

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- **Inquadramento**  
**Introduction**
- **Rete di monitoraggio idrometrico**  
**Gauging network**
- **Colate detritiche**  
**Debris flows**
- **Trasporto solido in sospensione**  
**Suspended sediment transport**
- **Trasporto solido al fondo**  
**Bed load**
- **Note conclusive**  
**Final remarks**



# Inquadramento normativo e strumenti

## Regulations and instruments

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Direttiva Acque 2000/60/CE  
Direttiva Alluvioni 2007/60/CE

Decreto Legislativo 3 aprile 2006, n.152  
Norme in materia ambientale

Legge provinciale 11 Agosto 1997, n.13  
Legge urbanistica provinciale

Legge provinciale 18 giugno 2002, n. 8  
Disposizioni sulle acque

**Piani di gestione dei bacini idrografici**

**Piani di gestione del rischio alluvioni**

**Piano di gestione degli invasi**

**Piano generale di utilizzazione delle acque**

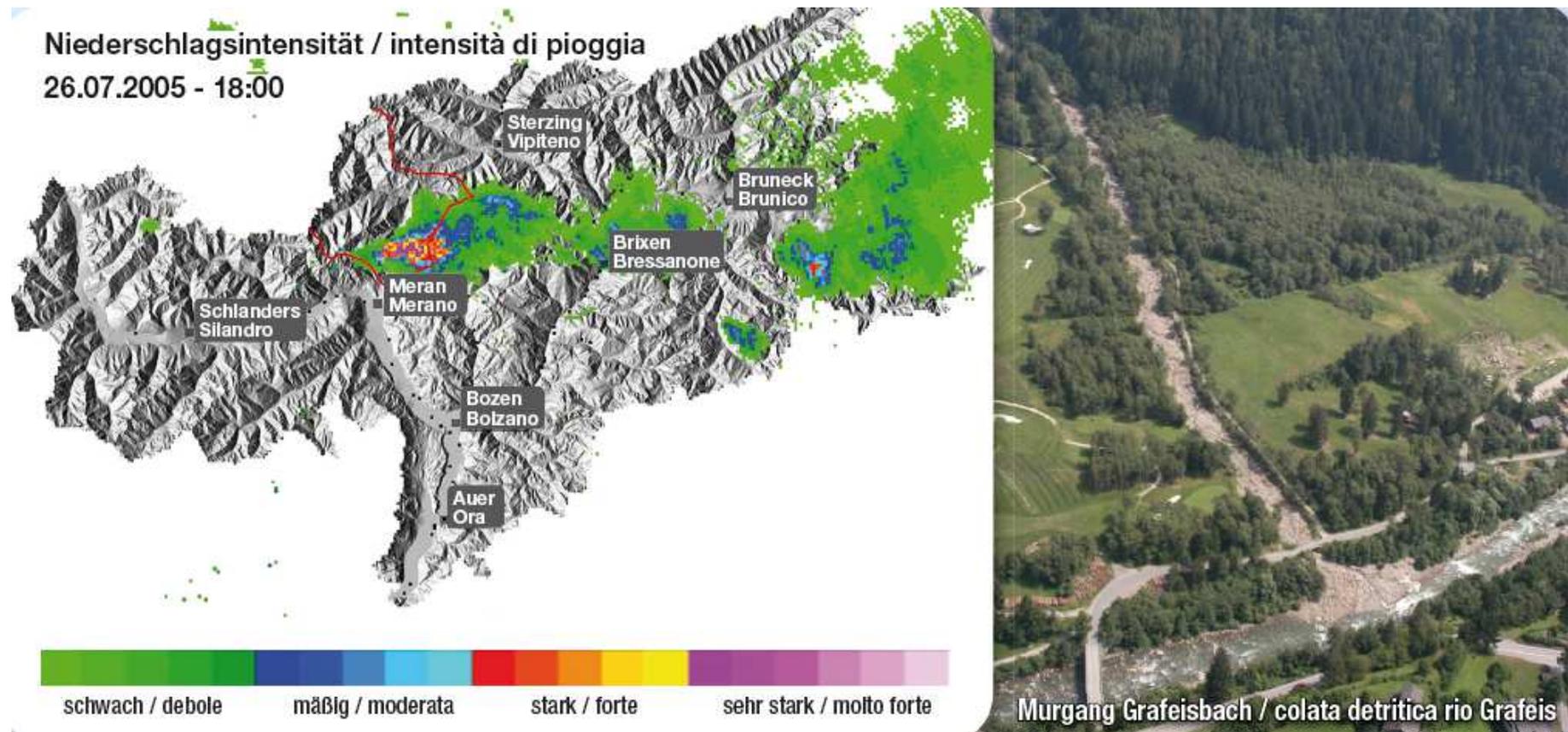
**Piano di Tutela delle acque**

**Piani comunali delle zone di pericolo**



# Inquadramento dei fenomeni

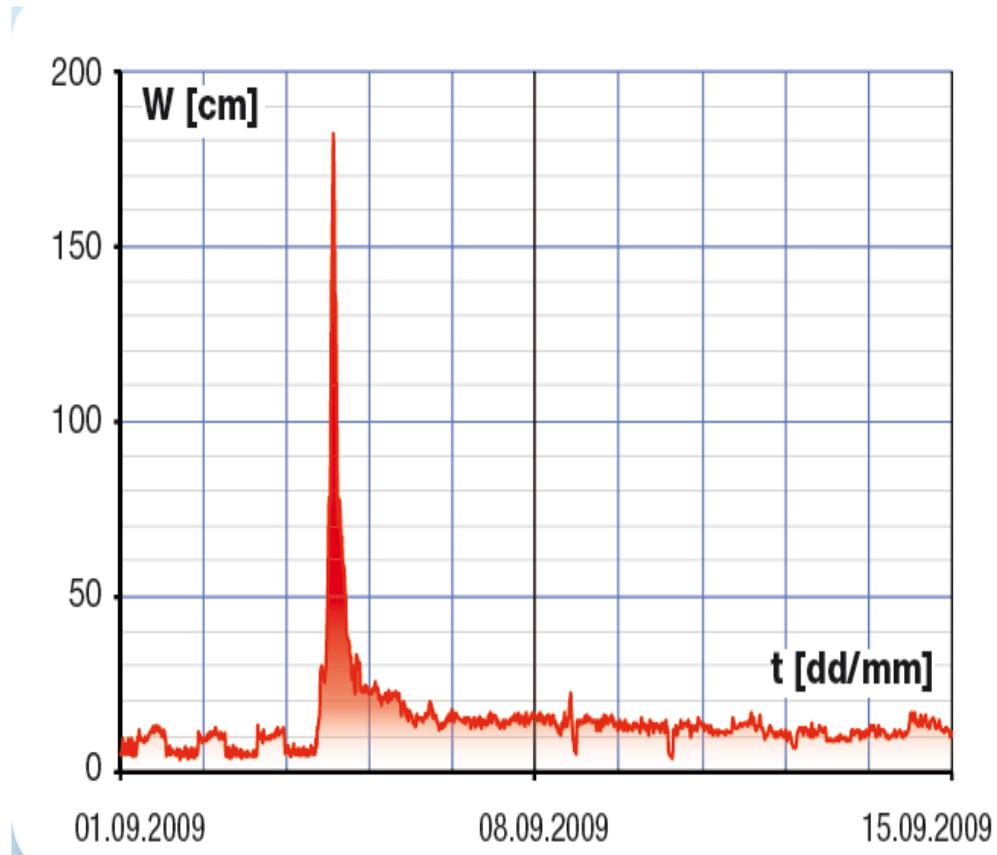
## Types of phenomena



# Inquadramento dei fenomeni

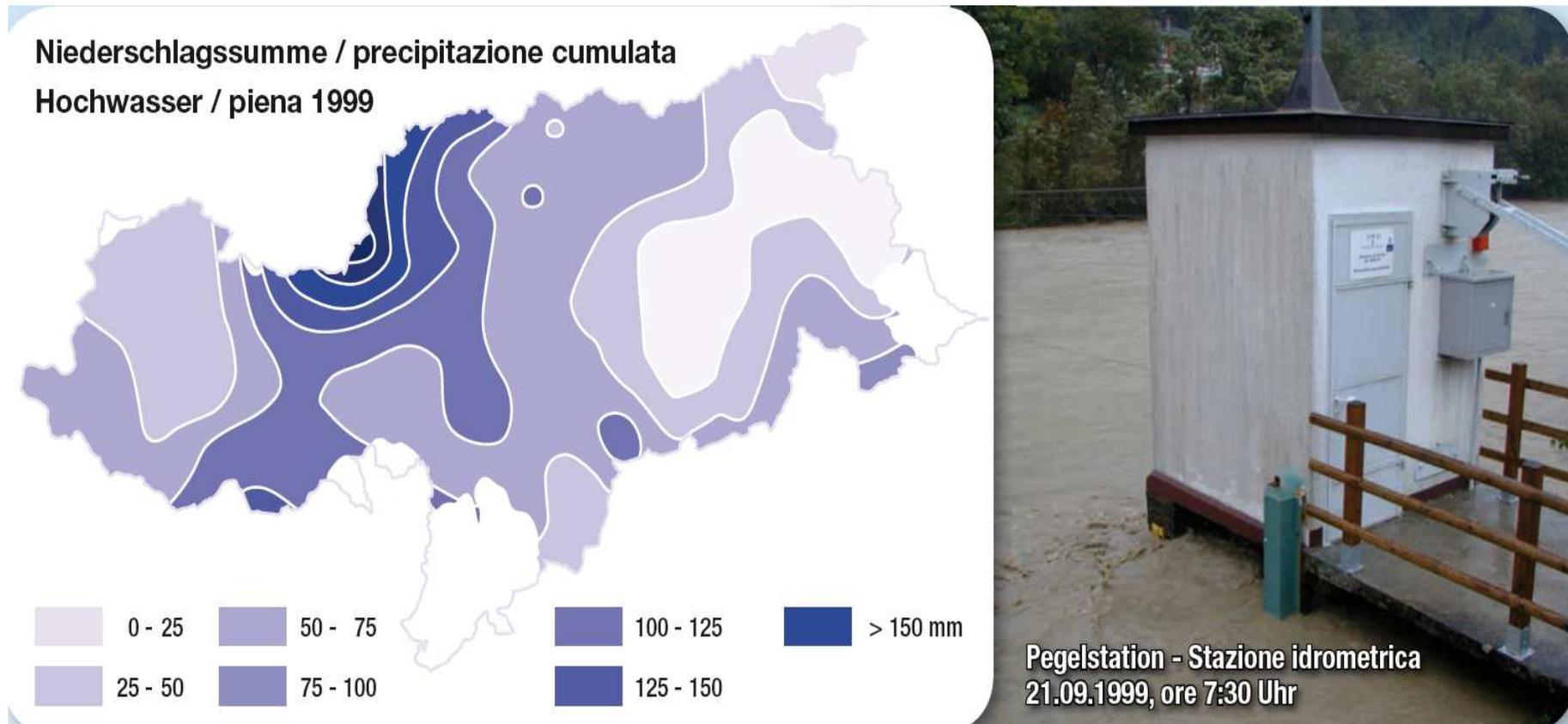
## Types of phenomena

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# Inquadramento dei fenomeni

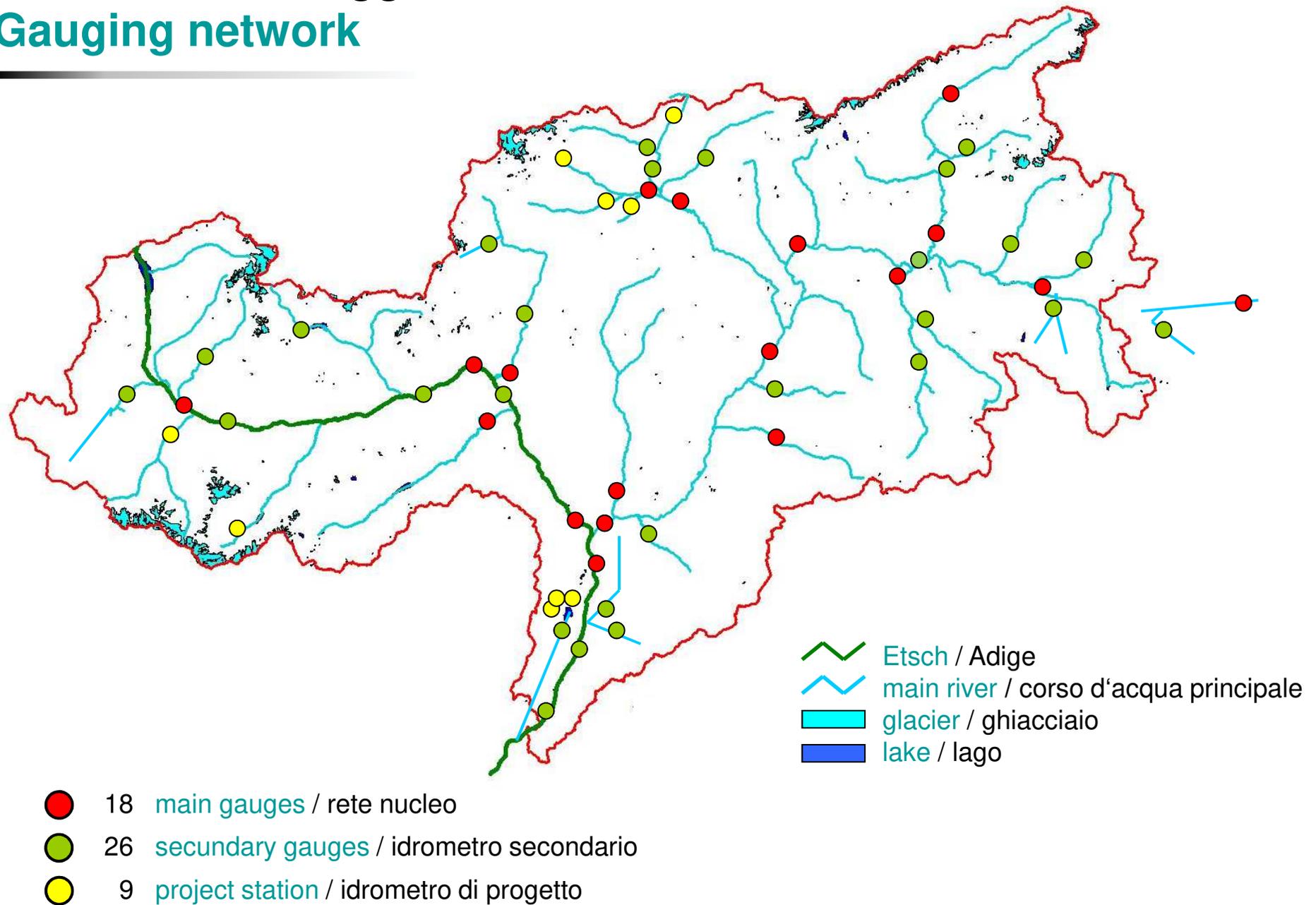
## Types of phenomena



# Rete di monitoraggio idrometrico

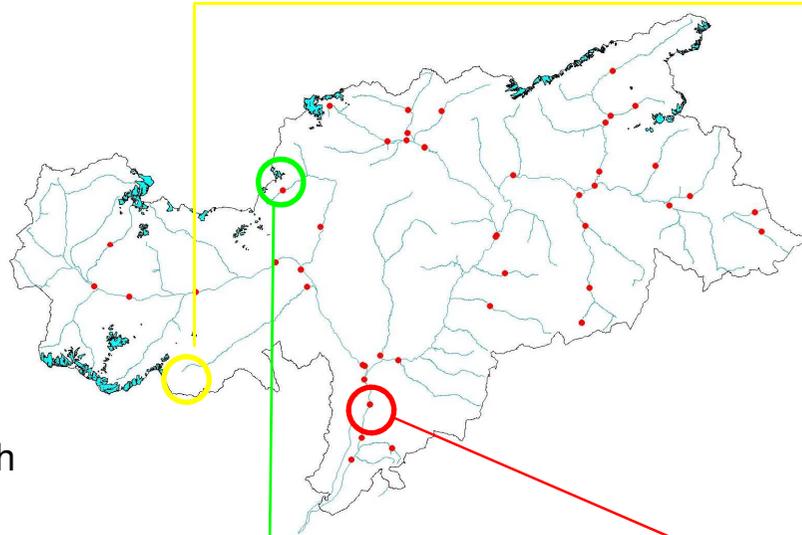
## Gauging network

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# Rete di monitoraggio idrometrico

## Gauging network



Eschbaum  
Rio Plan / Pfeldererbach  
70 km<sup>2</sup>

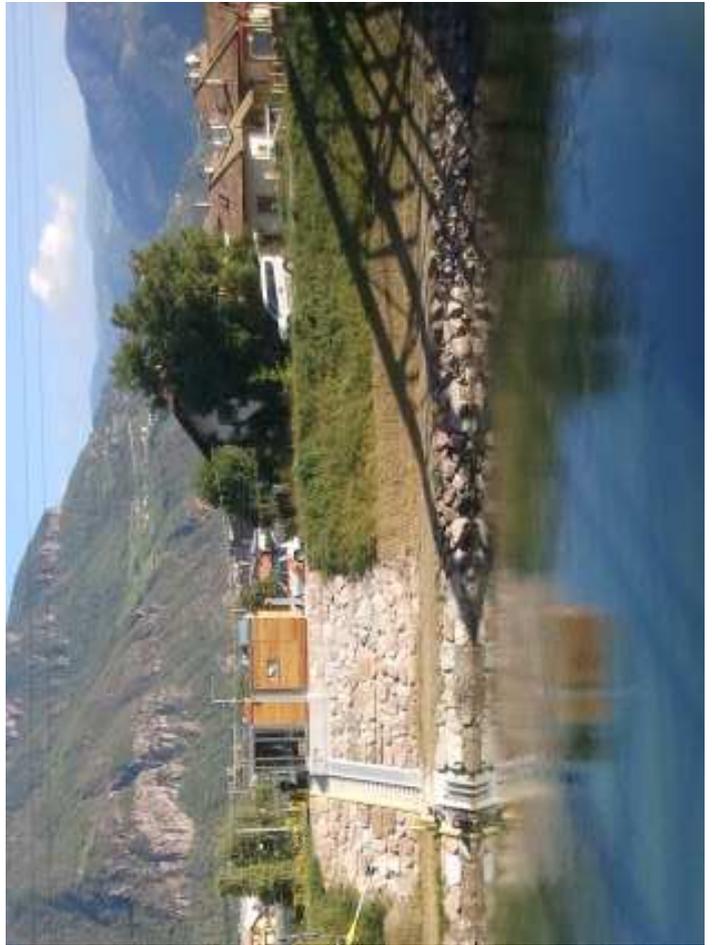
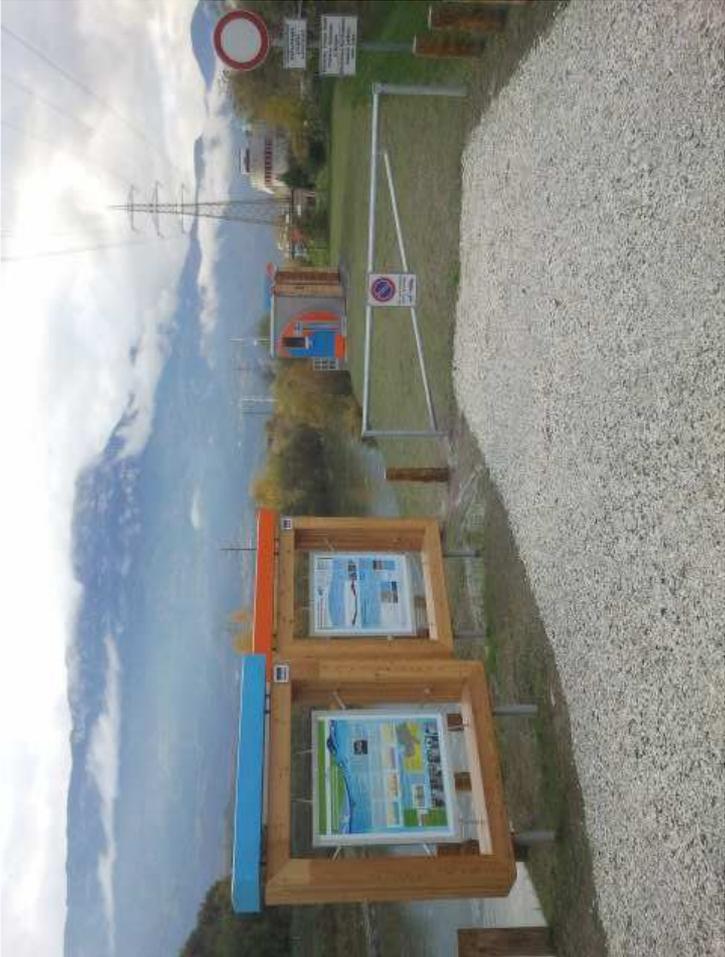


Weissbrunnferner  
Ghiacciaio di Fontana Bianca  
2 km<sup>2</sup>



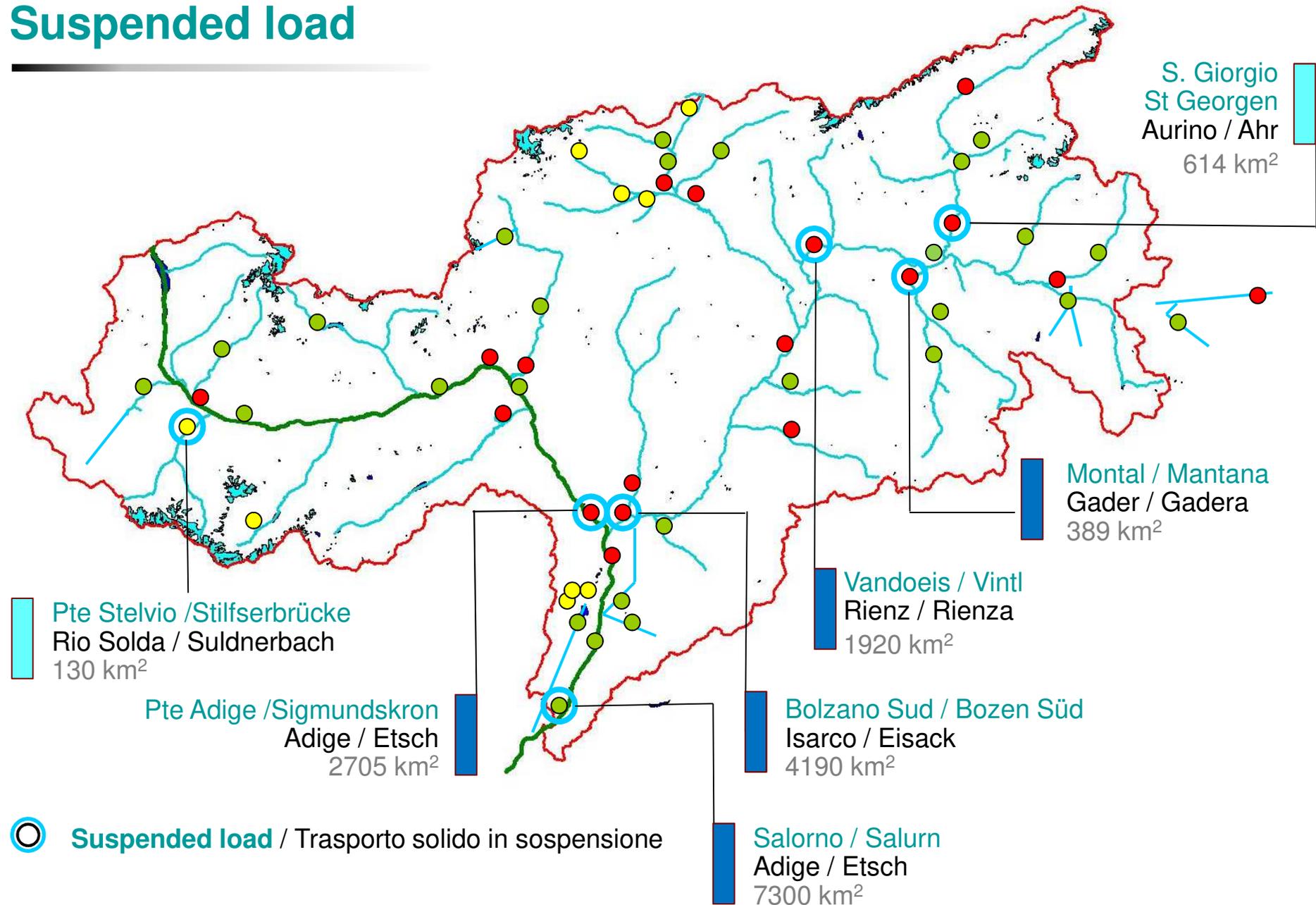
Adige / Etsch  
Bronzolo / Branzoll  
Pfeldererbach  
6900 km<sup>2</sup>





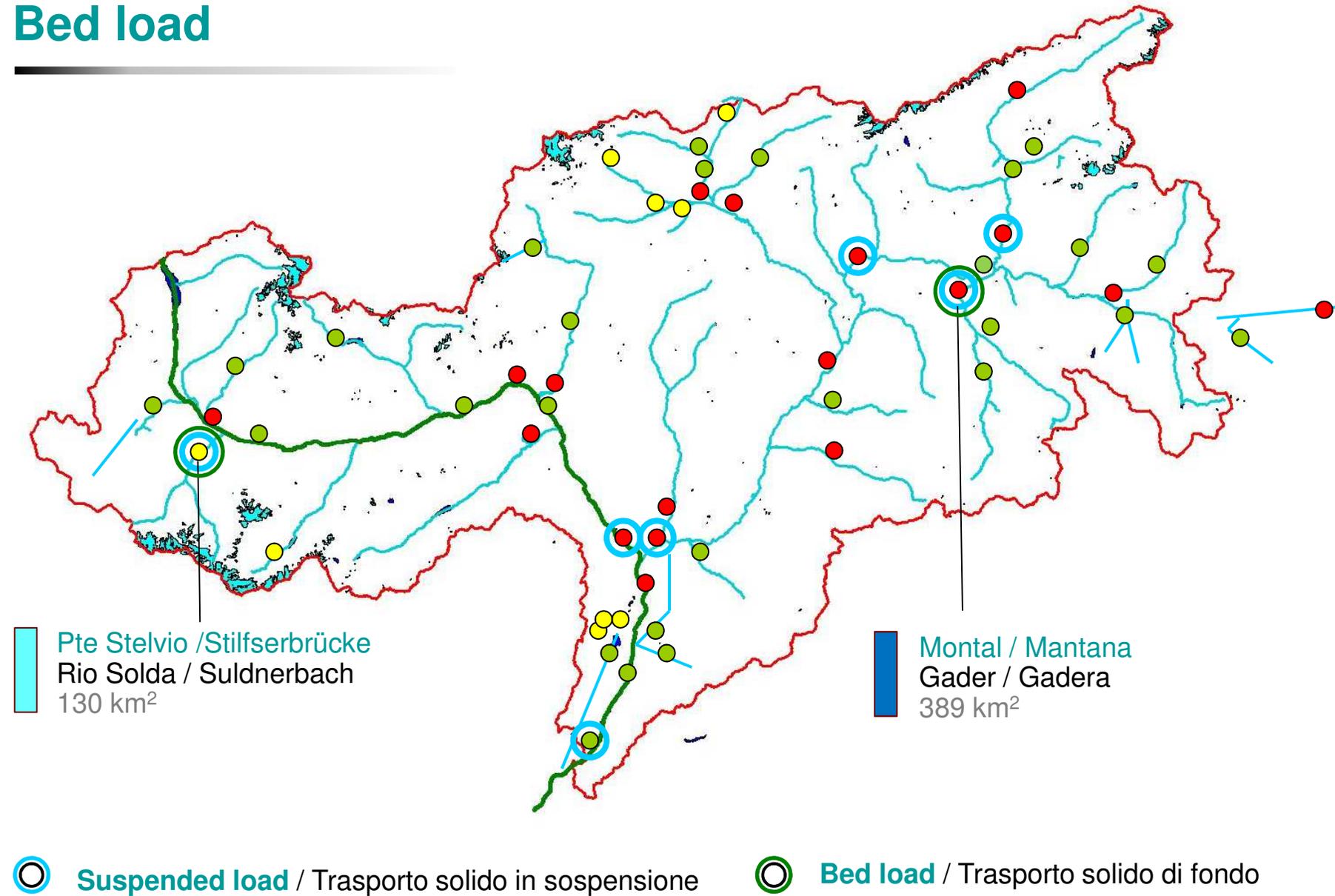
# Trasporto solido in sospensione

## Suspended load



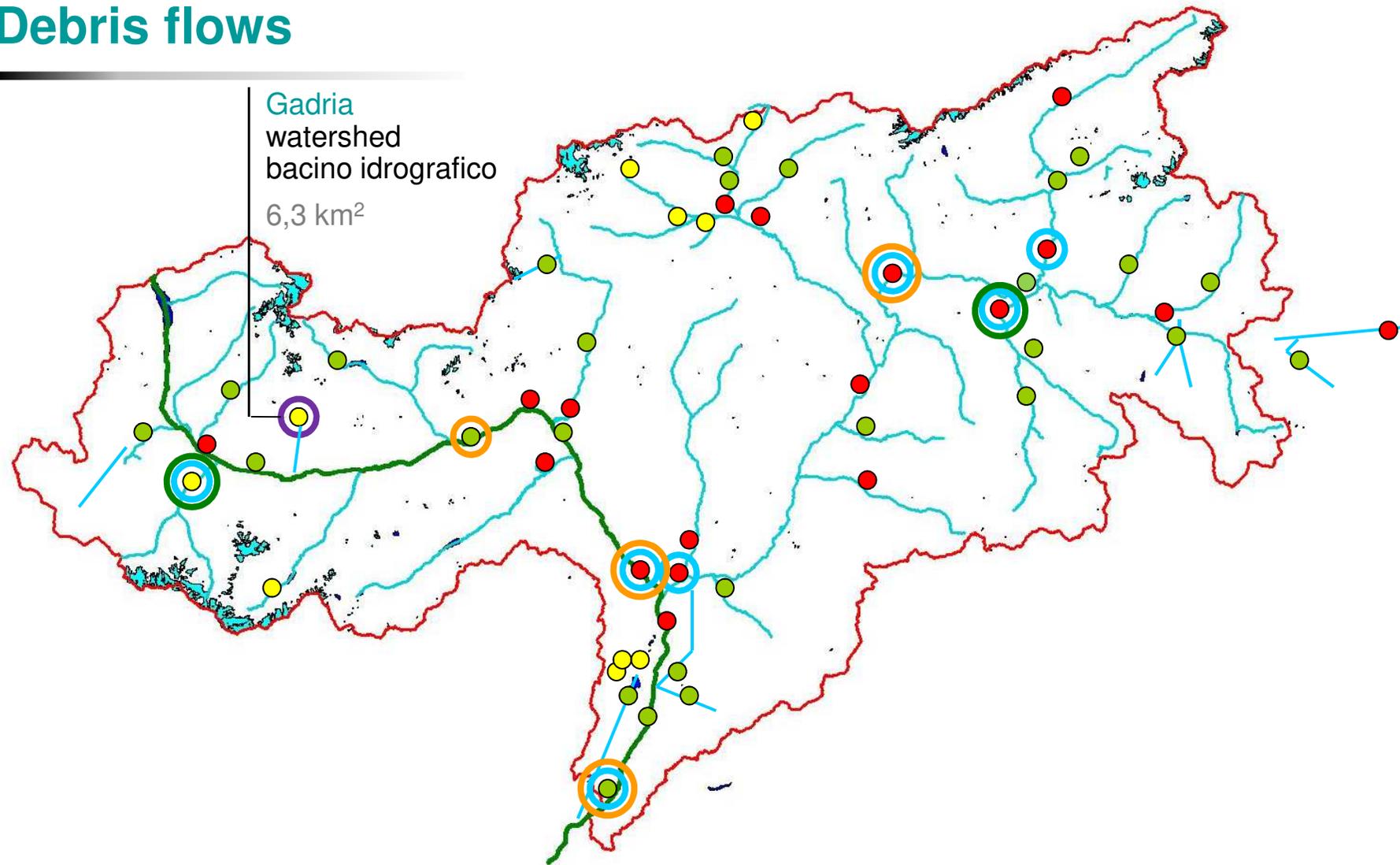
# Trasporto solido al fondo

## Bed load



# Colate detritiche

## Debris flows



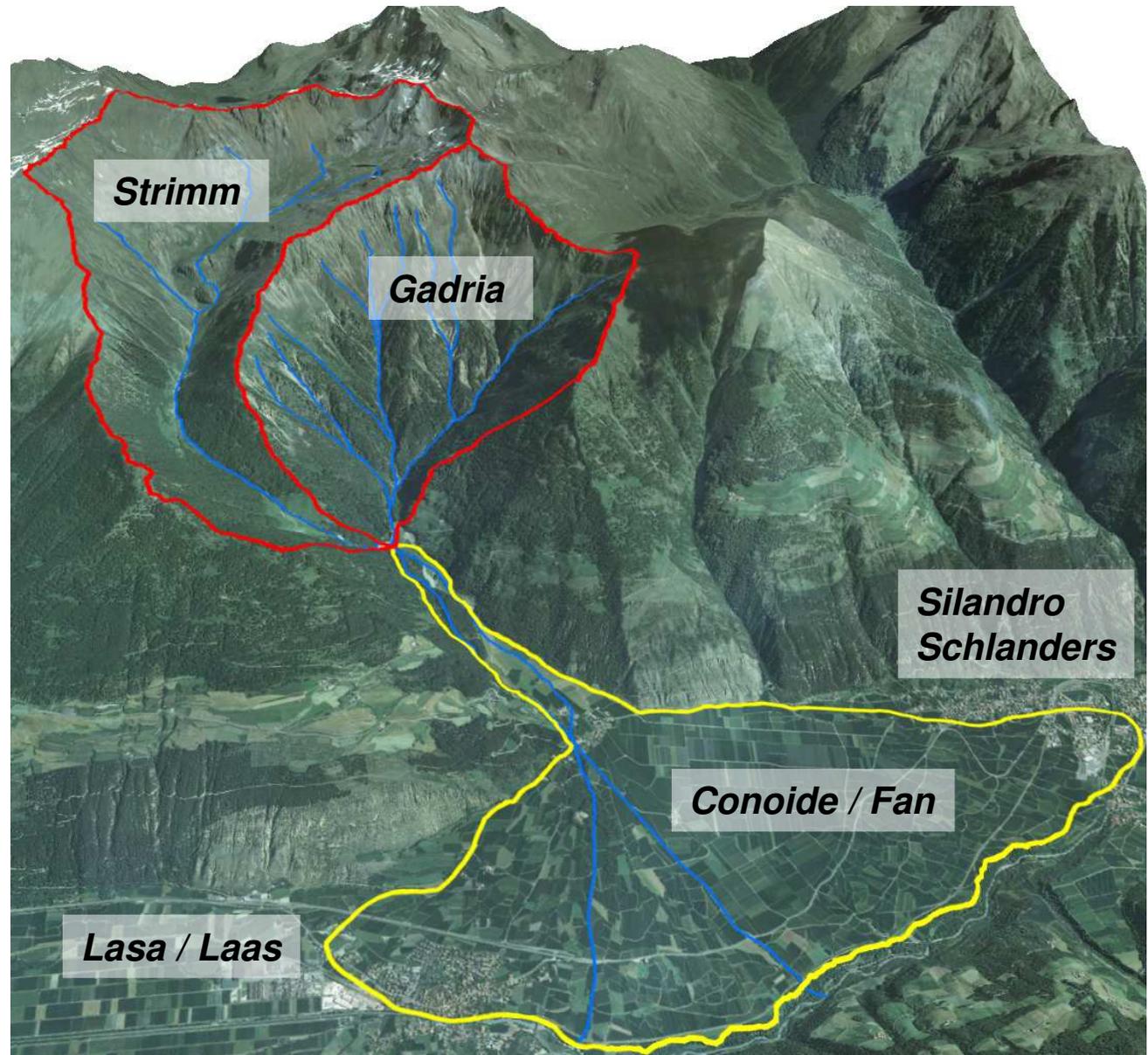
- **Suspended load** / Trasporto solido in sospensione
- **Debris flow** / Colate detritiche

- **Bed load** / Trasporto solido di fondo
- **Water quality** / Qualità dell'acqua

# GADRIA Sistema di monitoraggio delle colate detritiche

## Debris flow monitoring system

$S_{\text{GADRIA}}$	6.3 km <sup>2</sup>
$S_{\text{STRIMM}}$	8,5 km <sup>2</sup>
$S_{\text{FAN}}$	10.9 km <sup>2</sup>
$H_{\text{min}}$	1394 m a.s.l..
$H_{\text{max}}$	2945 m a.s.l..
$NN_{\text{YEAR}}$	500 mm/year
$f_{\text{DEBRIS}}$	1/year



# GADRIA Sistema di monitoraggio delle colate detritiche

## Debris flow monitoring system

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BC Base Camp

Videocamere

Idrometri radar

Geofoni

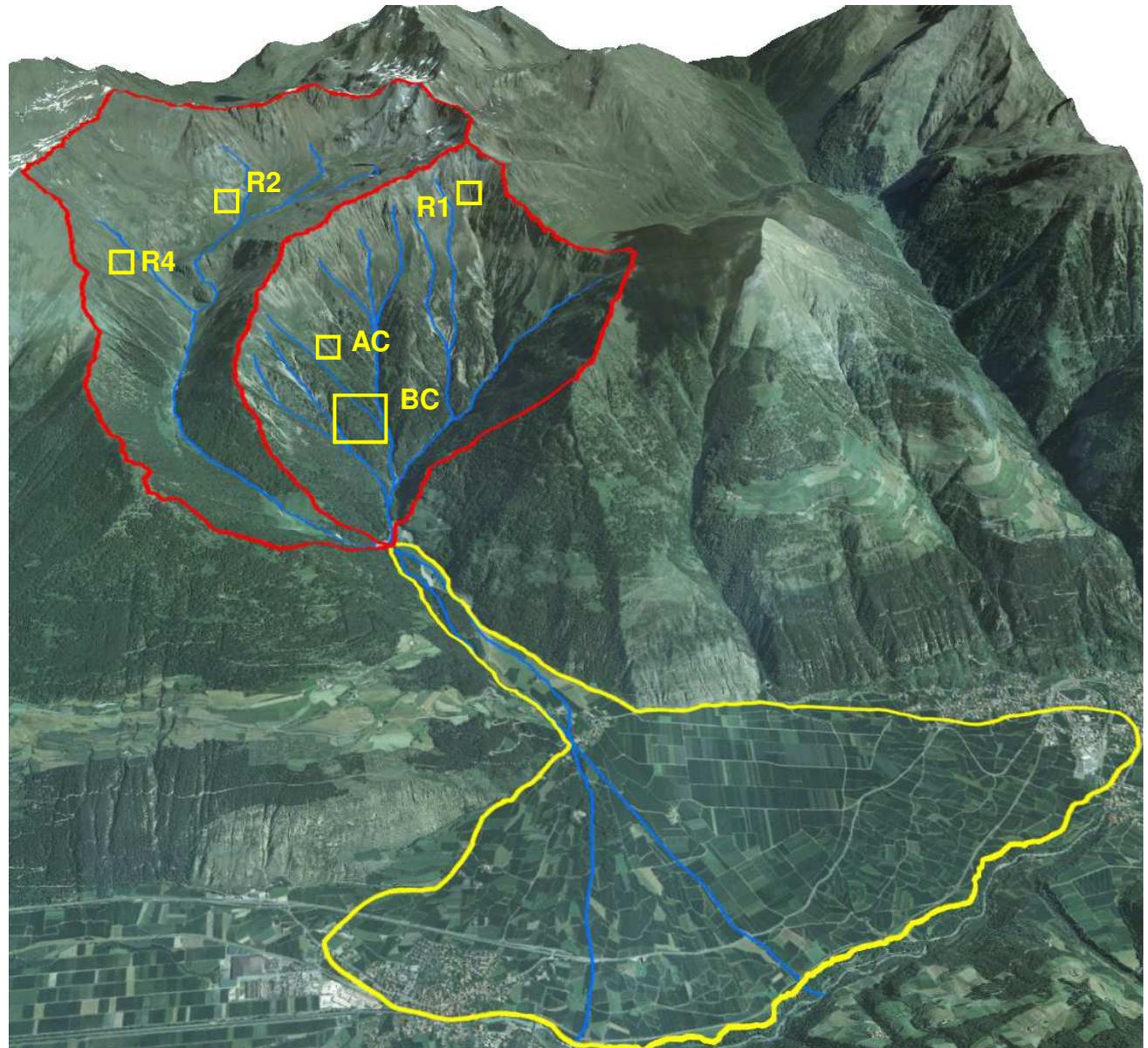
AC Advanced Camp

Idrometro Radar

Pluviometro

R1, R2, R4

Pluviometri



# GADRIA Sistema di monitoraggio delle colate detritiche

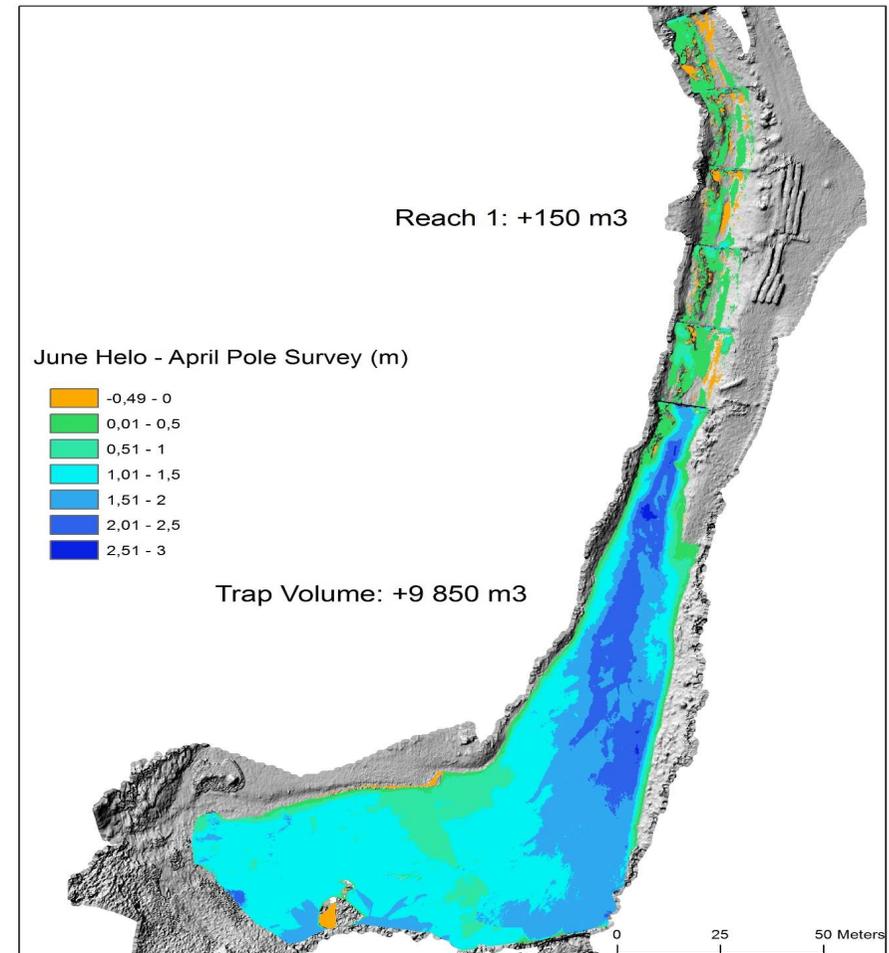
## Debris flow monitoring system

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# GADRIA Sistema di monitoraggio delle colate detritiche

## Debris flow monitoring system

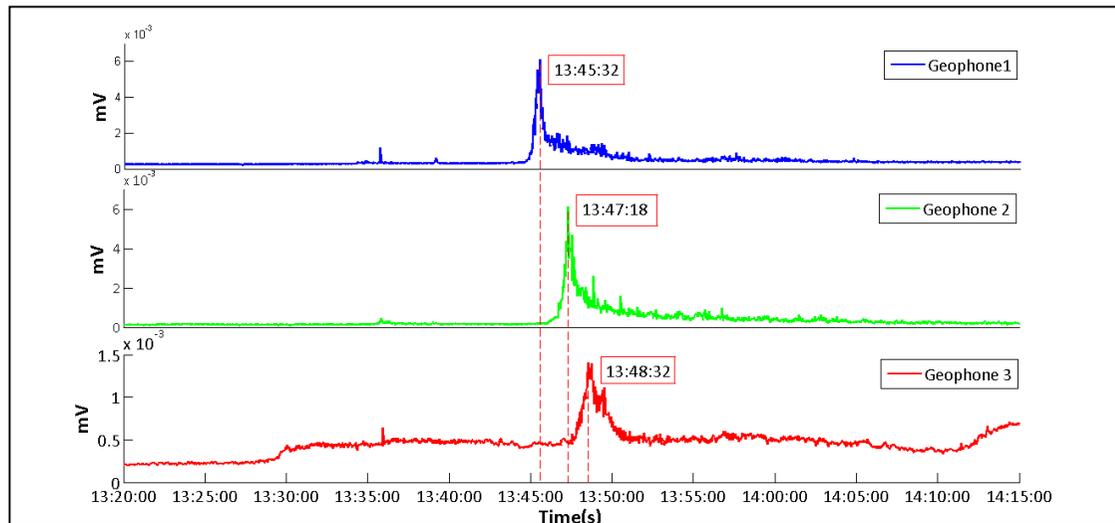
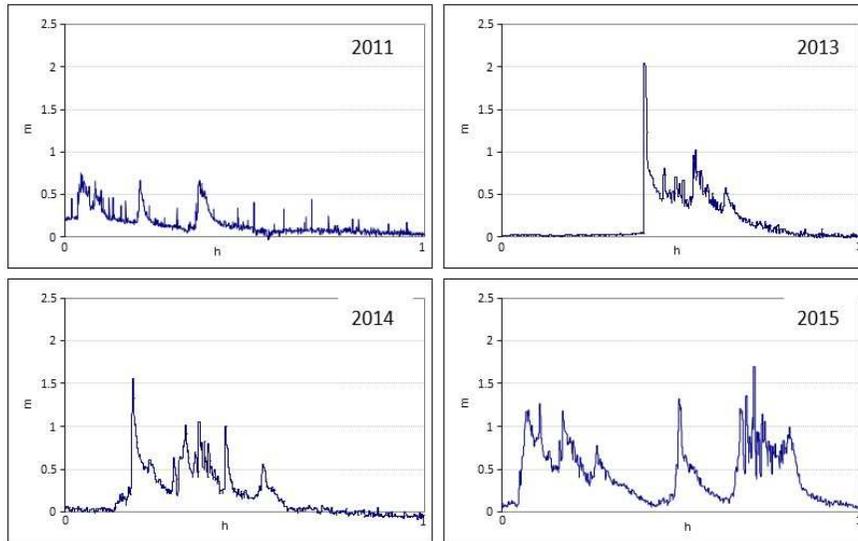


Immagini e video  
Images and videos

Stima volumi  
Volume estimation

# GADRIA Sistema di monitoraggio delle colate detritiche

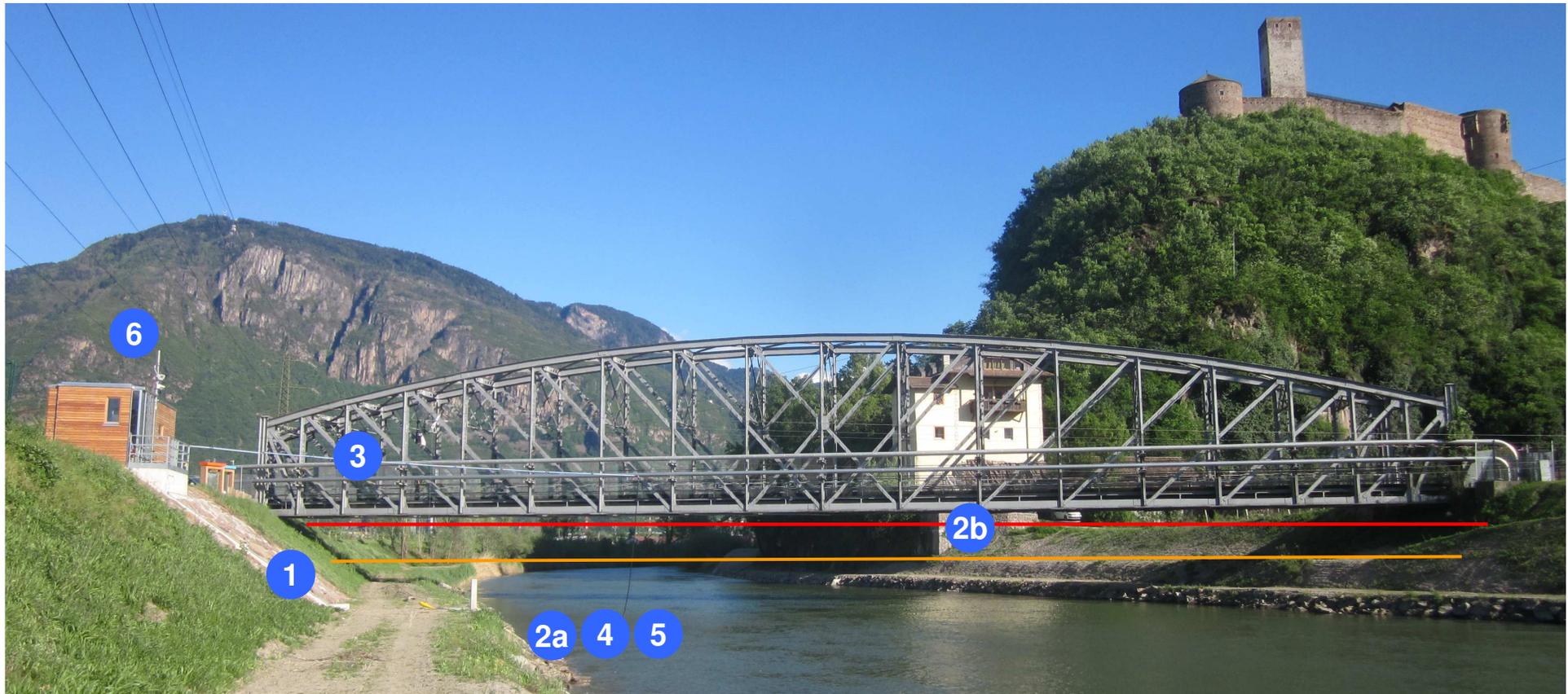
## Debris flow monitoring system



Altezza e velocità del flusso  
Flow depth and speed

# Trasporto solido in sospensione

## Suspended sediment transport



- 1 Water level stock / asta idrometrica
- 2a pressure sensor / sonda di pressione
- 2b radar sensor / sensore radar
- 3 Cableway / teleferica idrometrica

- 4 Horizontal ADP / ADP orizzontale
- 5 Turbidimeter / Torbidimetro
- 6 Redundant real-time datatransfer  
trasmissione dati real time ridondante

# Fasi di lavoro

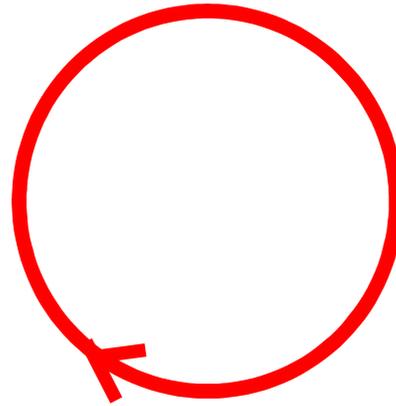
## Workflow

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step 2

step 1



step 3



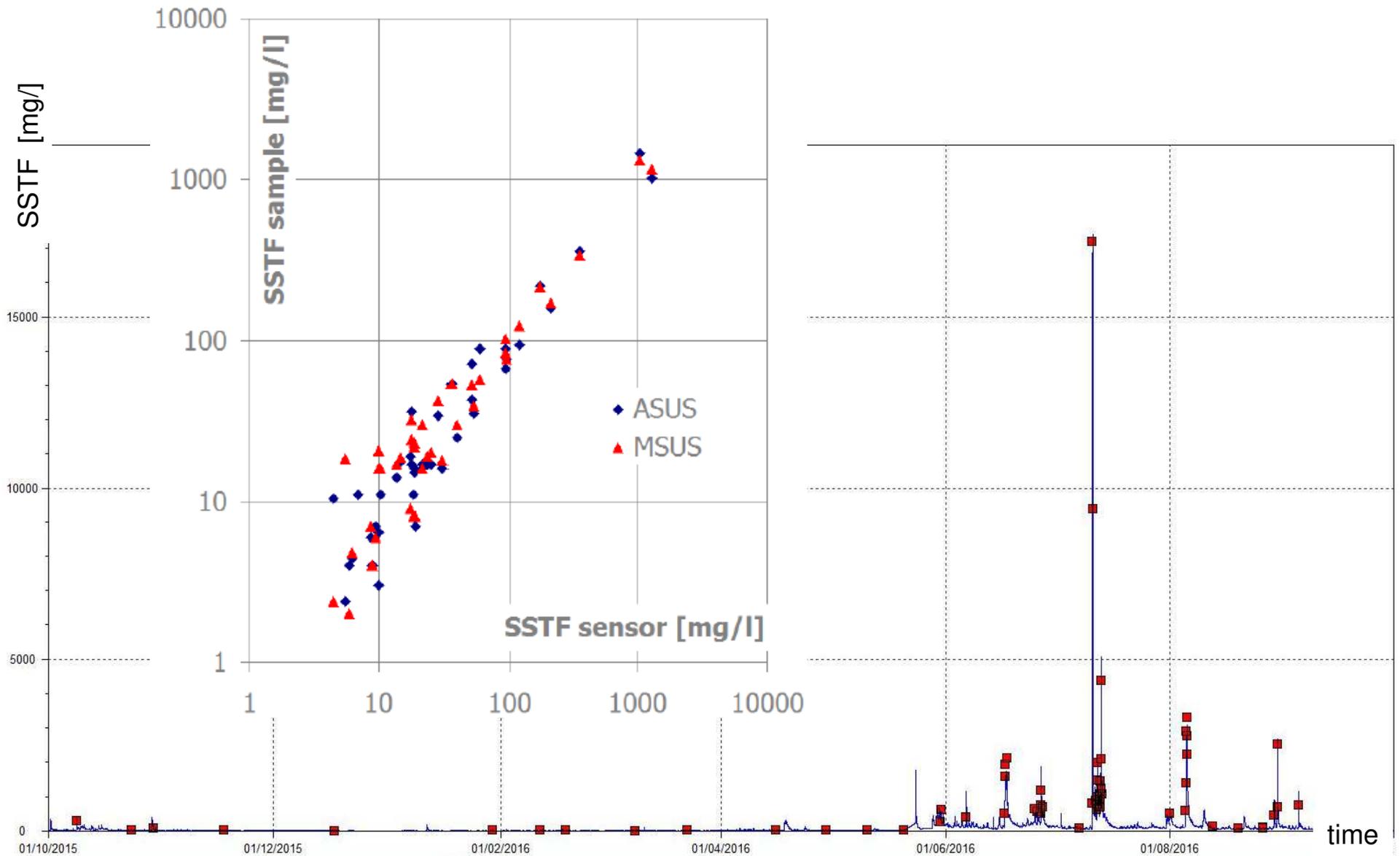
step 4



step 5

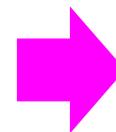
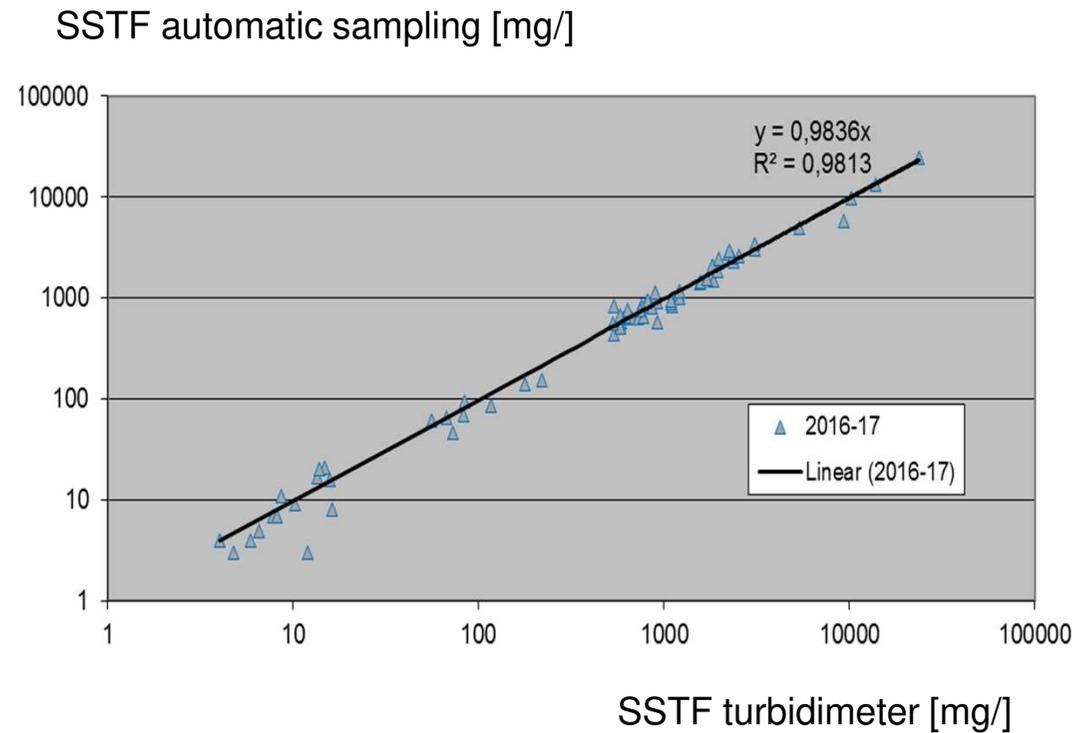
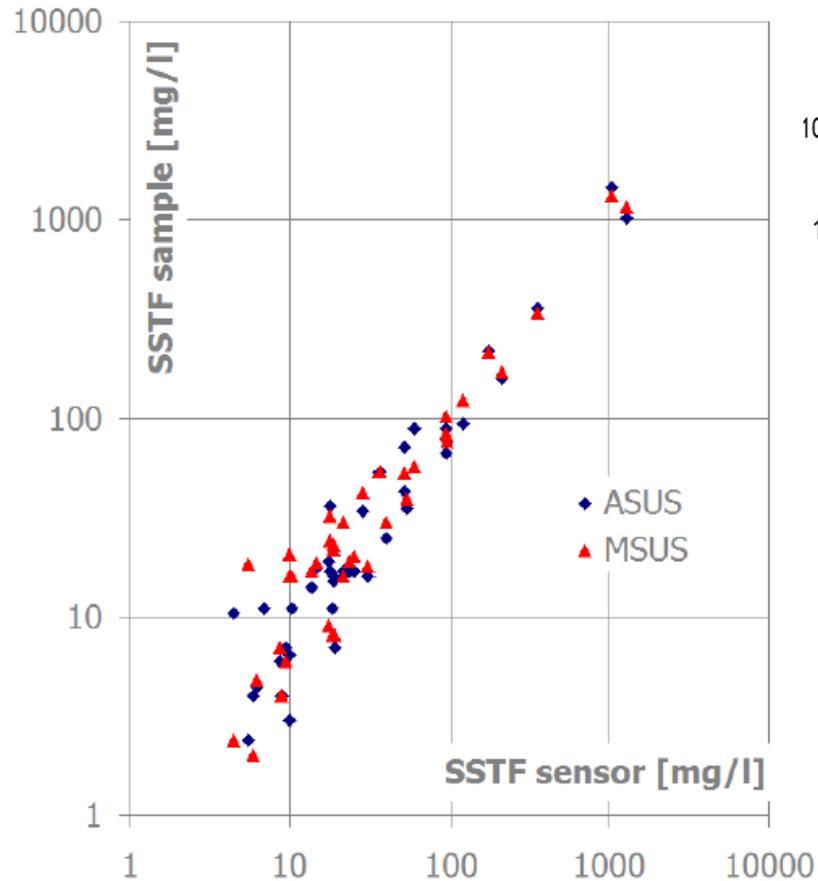
# Calibrazione della misura torbidimetrica

## Calibration of turbidimeter measurements



# Calibrazione della misura torbidimetrica

## Calibration of turbidimeter measurements



**Fattore di sonda / Turbidimeter factor**

# Test campionatori automatici

## Automatic samplers test

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**Hach Lange SD900**

- prevalenza / prevalence
- quantità campionamento  
sampling quantity
- qualità campionamento  
samping quality

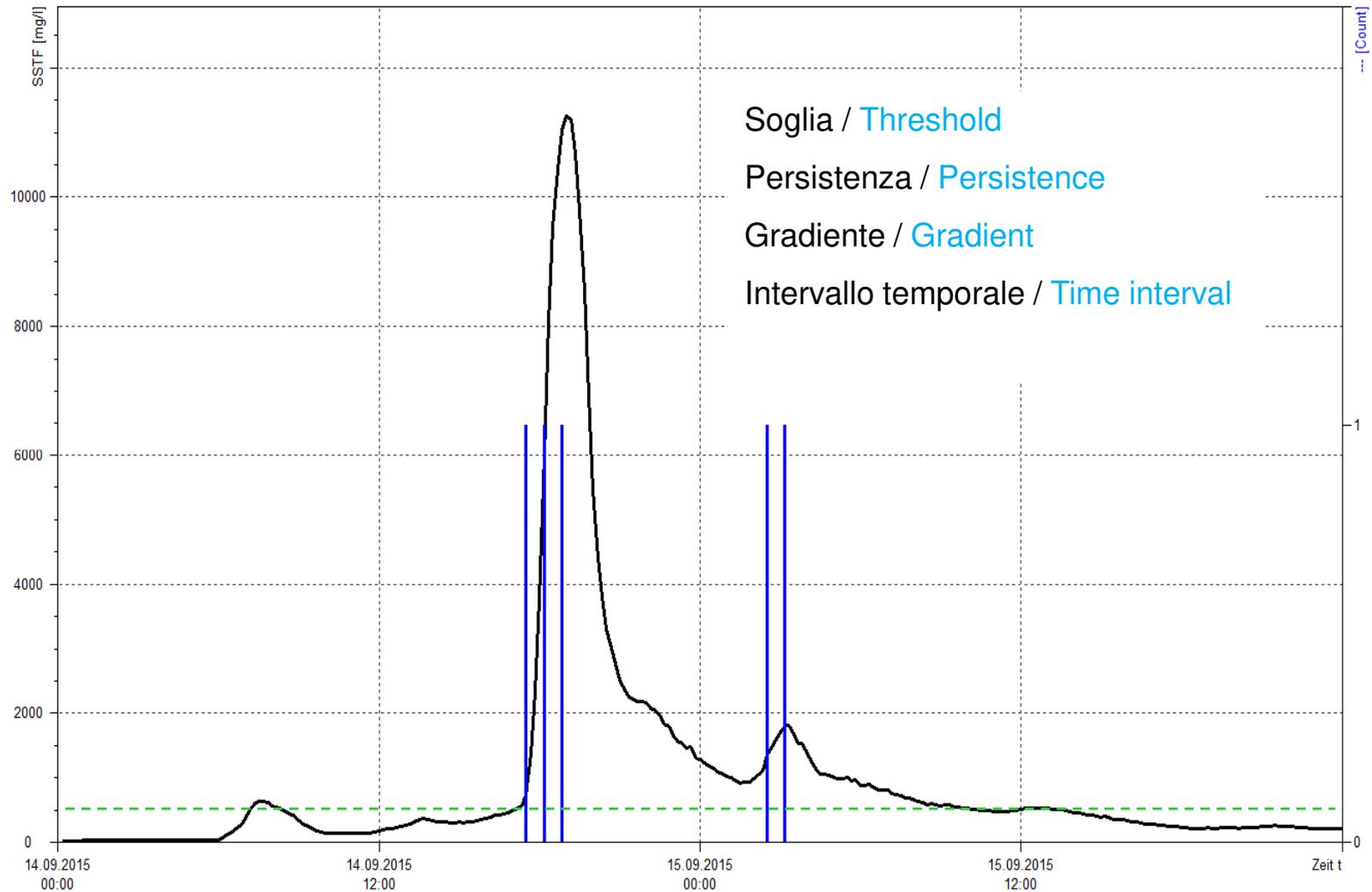


**Bühler 4011**



# Campionamento automatico a evento

## Event triggered automatic sampling



# US P61 Campionatore Sampler

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Alimentazione a 48 V

Telecomando radio

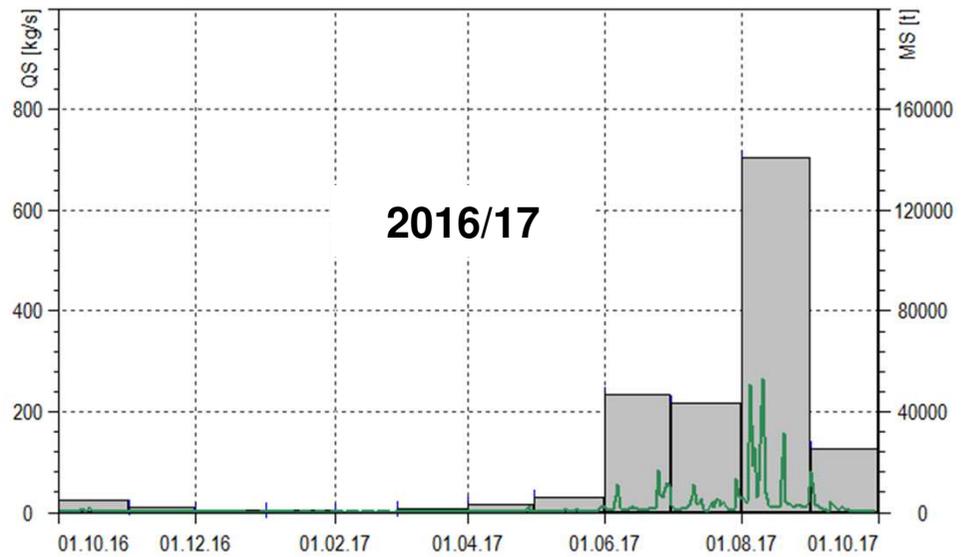
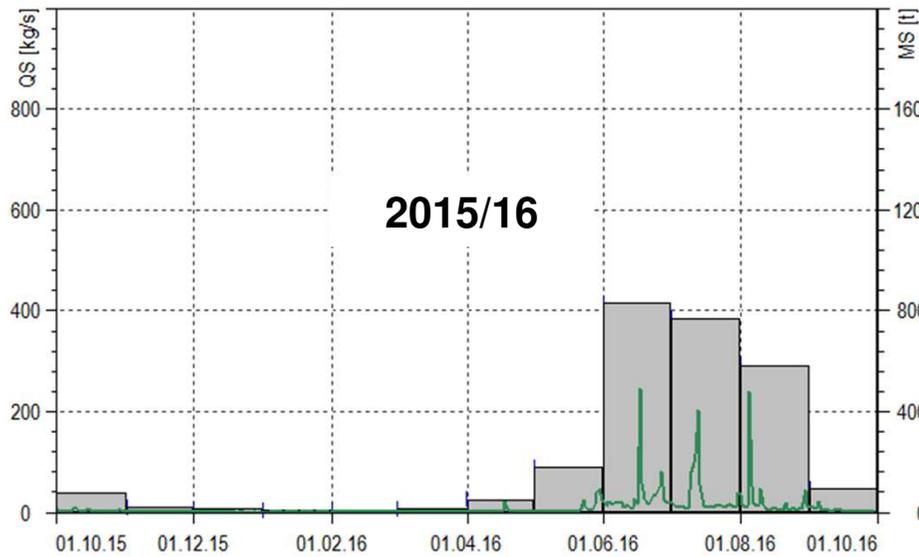
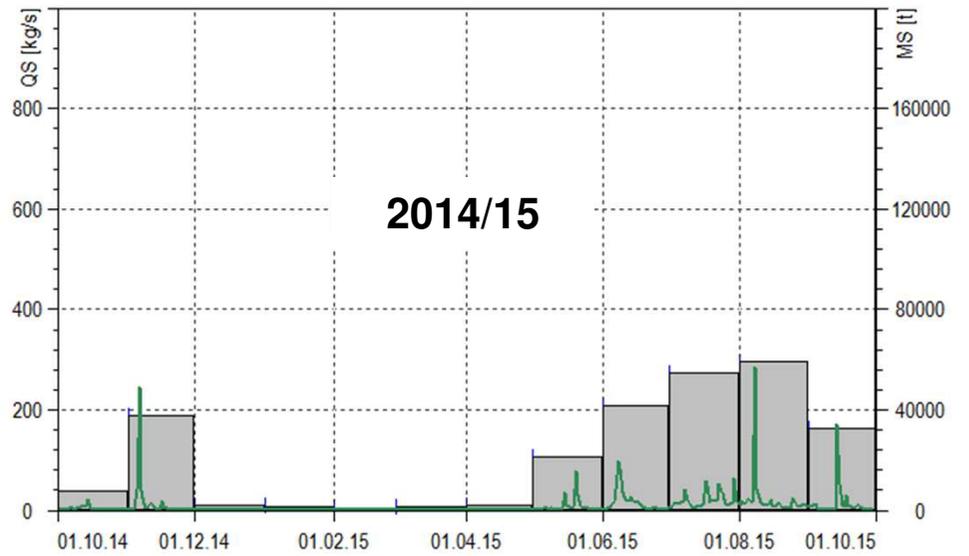
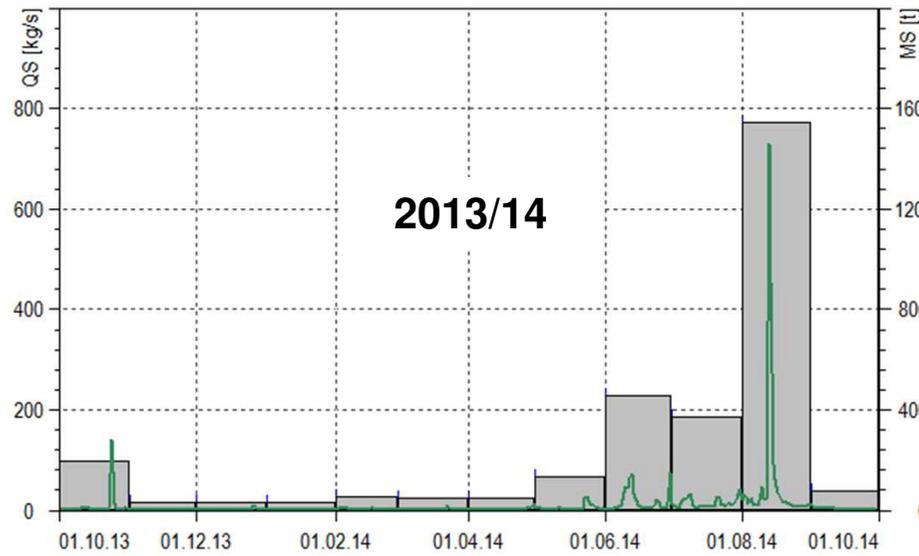
Sistema isolato verso terra (sicurezza elettrica)

Durata campionamento Impostabile



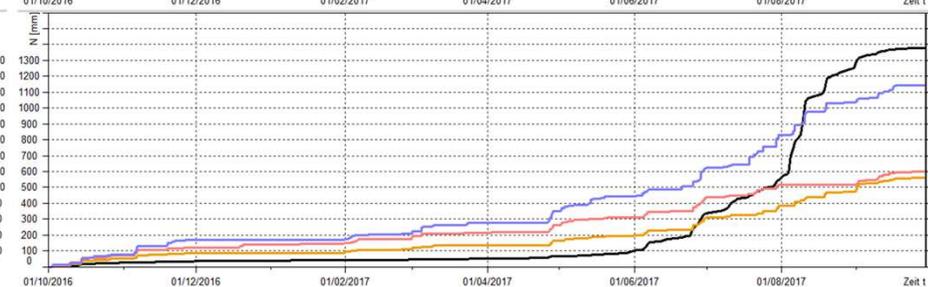
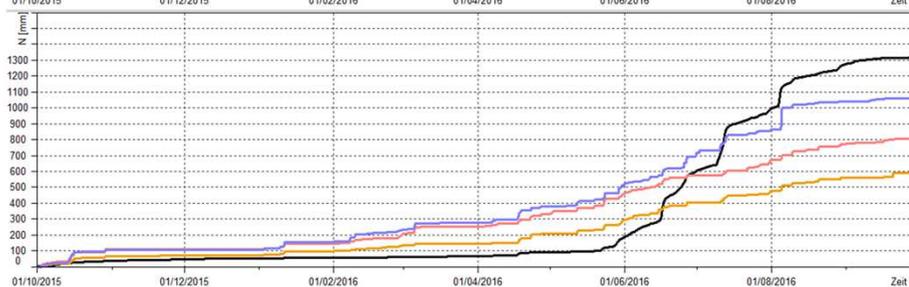
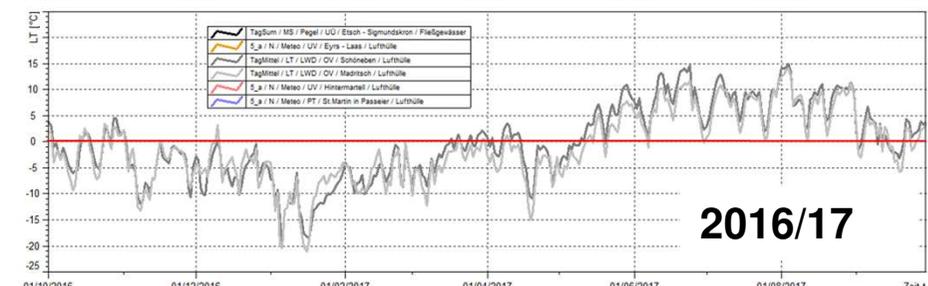
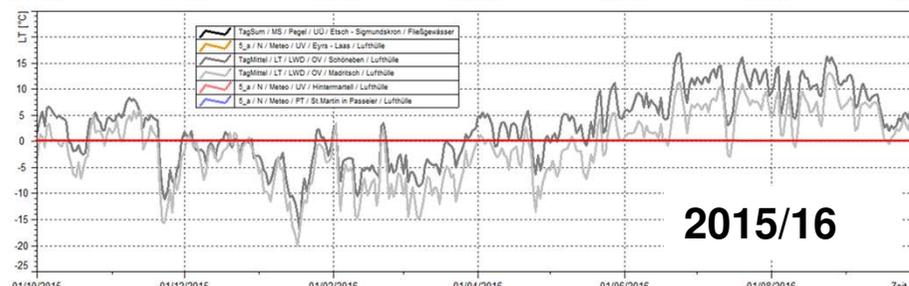
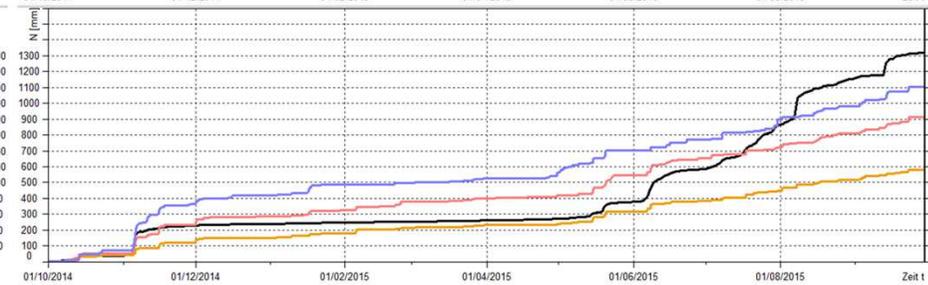
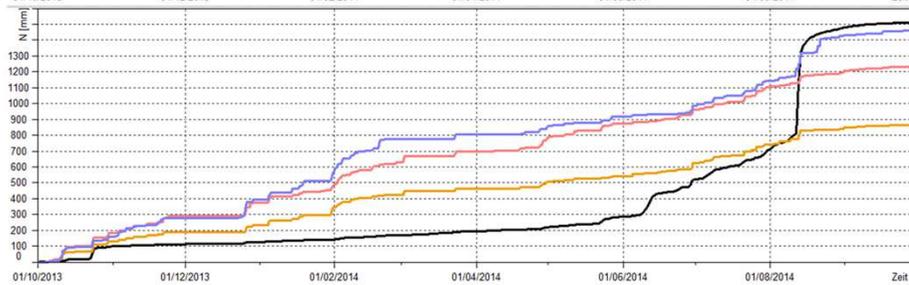
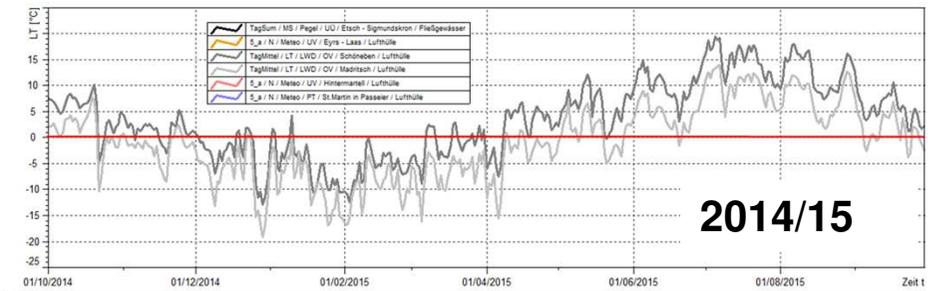
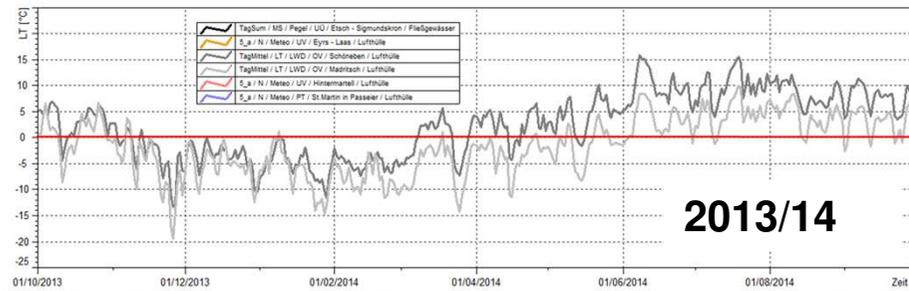
# Risultati

## Results



# Risultati

## Results



# Trasporto solido al fondo

## Bed load

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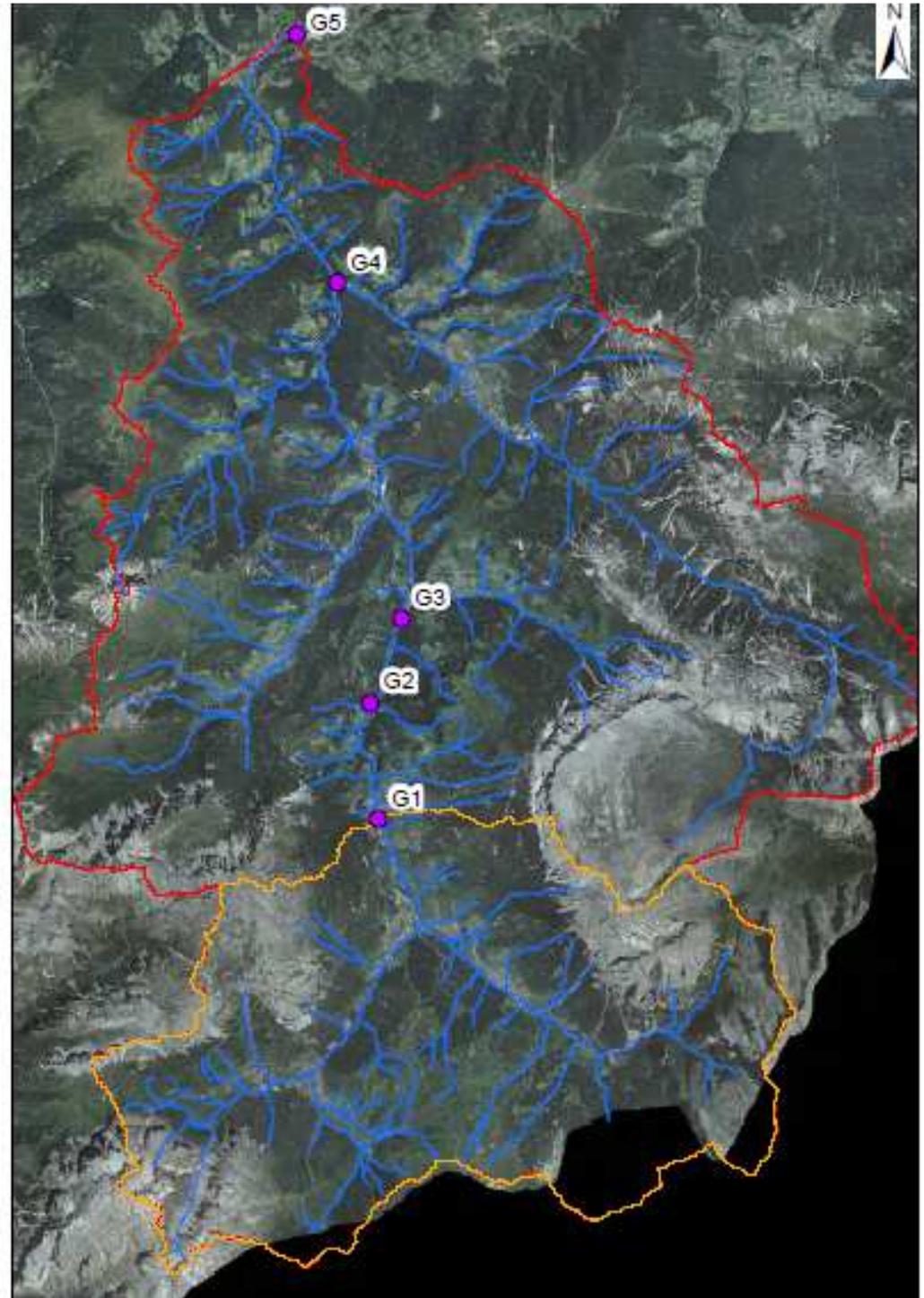


# Studio di fattibilità

## Fesaibility study

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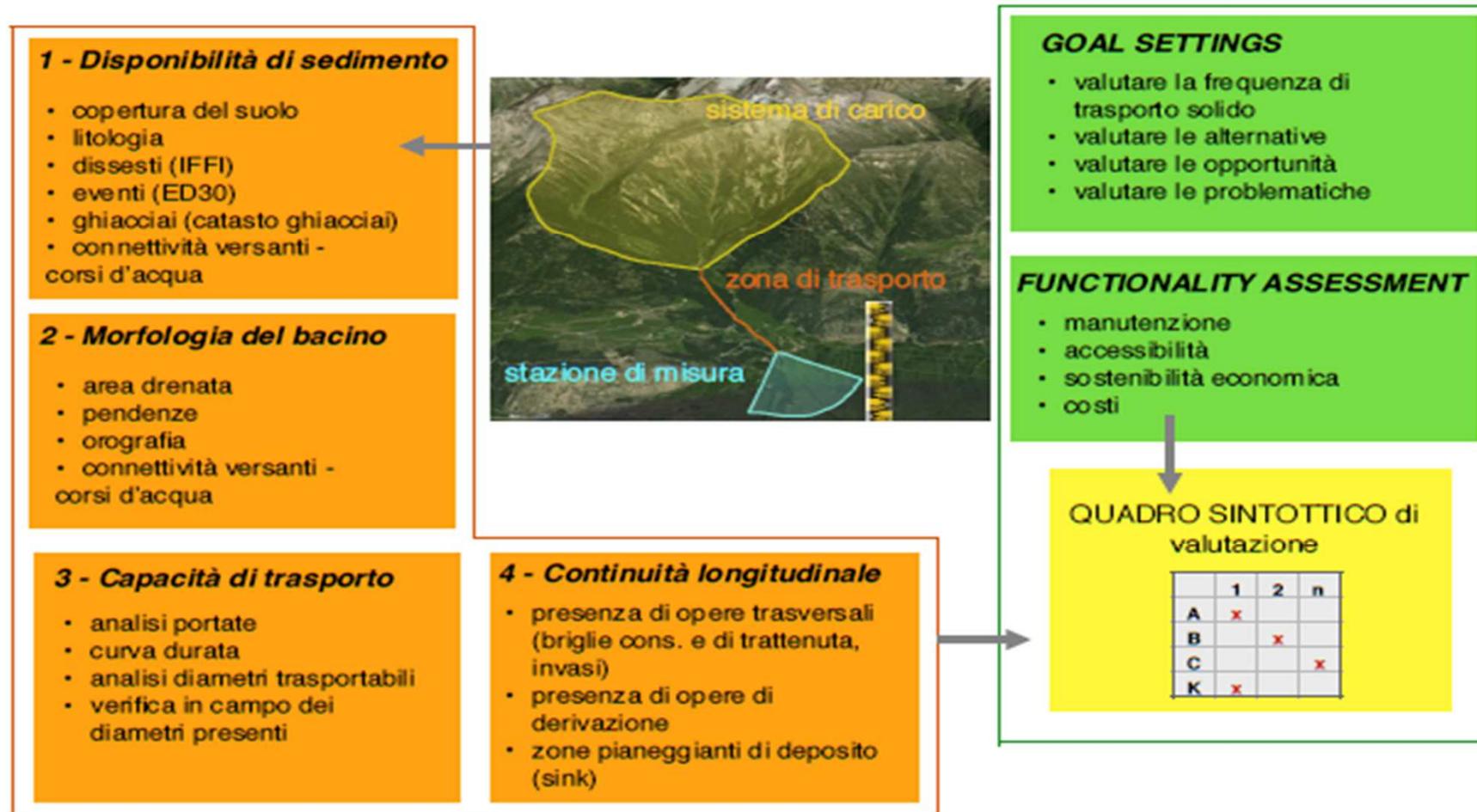
$H_{MAX}$	3120 m a.s.l.
$S_{EROSION}$	36,5 km <sup>2</sup> .
$S_5$	389 km <sup>2</sup>
$H_{MIN, 5}$	817 m a.s.l.
$S_1$	121 km <sup>2</sup>
$H_{MIN, 1}$	1324 m a.s.l.
.	
NN	1000 mm/year



# Studio di fattibilità

## Fesaibility study

### ANALISI - SCHEMA CONCETTUALE OPERATIVO



# Studio di fattibilità

## Fesaibility study

Criteria	Downstream Bridge		Middle position		Upstream Bridge		Rebuilt upstream Bridge		Notes
	Points		Points		Points		Points		
Basket sampling	3	Sampling is possible through the whole cross section; Only 1 lane would be available for the crane	1	Sampling is possible for half of the cross section	2	Operation is difficult due to high flow velocity	2	Operation is difficult due to high flow velocity	Variation on the cross section transport expected, multipoint sampling suggested for calibration. Basket samplers needs to be fixed with tethers on riverbank
Bedload trap (Slot sampler) either stationary version or liftable	1	sedimentation possible	2	sedimentation?	3	no sedimentation possible	3		Risk that trap system gets covered with fine sediments (see geophones)
Geophone installation	1	wide cross section, high cost and high variability along it. Asymmetric profile needed	3	good, narrow section	3	good, narrow section	3	good, narrow section	Risk that geophone system gets covered with fine sediments
Gauging	2	wide cross section, problematic in low flow condition	3	good enough (no diagonal fronts) with the new configuration	2	Measure quality affected by bridge piers	3	To be designed with no piers	
Turbidity	2	wide cross section (time consuming), correction factor required	3	narrow section, less time consuming	3	narrow section, less time consuming	3	narrow section, less time consuming	Variation on the cross section transport expected
Cableway	3	wider cross section, longer cable	3	ok	3	ok	3	ok	Location depends on basket sampler measurement concept. Tethers needed for basket sampler (Bunte type, LHS) must not cross cableway

# Studio di fattibilità

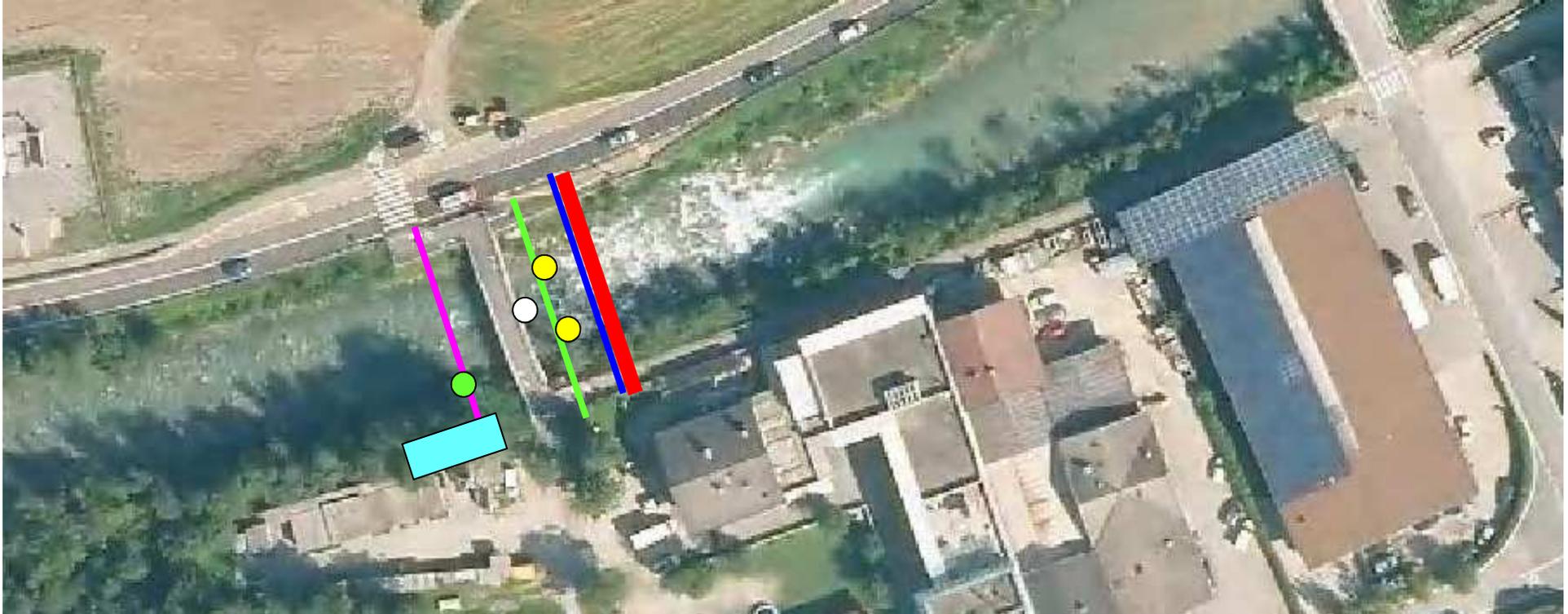
## Fesaibility study

Criteria	Downstream Bridge		Middle position		Upstream Bridge		Rebuilt upstream Bridge		Notes
	Points		Points		Points		Points		
Calibration pillar	2	Assuming not in line with the pears, it causes hydraulic hazard issue	2	not easily reachable with a crane from the lateral bank	1	Assuming not in line with the pears, it causes hydraulic hazard issue	3	ok	TIWAG System - Good for calibration, it provides high quality calibration data because the position of the sampler is controlled. Very limited number of sections
Bridge accessibility by the truck/crane	2	Limitation to the bridge accessibility (Traffic)	0	no bridge	0	carrying capacity of old bridge unlikely to support truck weight (ton max allowed/cycle path) Check the accessibility	3	To be designed to support the weight and bending moment due the truck and crane	If a new bridge will be designed, it could be used both for maintenance purposes and for basket sampling
Maintenance (accessibility from the riverbank or bridge)	2	wider cross section -> access via ramp is easier	2	An access ramp is needed, the narrower is the cross section, the steeper the ramp	2	An access ramp is needed, the narrower is the cross section, the steeper the ramp	3	if new bridge supports truck weight and bending moment	Access for heavy equipment (truck, excavator) needed to perform maintenance operations
Compatibility to gauging house	3	ok	3	ok	3	ok	3	ok	Already bought, so if possible let's use it as it is!
Bypass system	1	Limited space along the left reach, to be checked. Likely insufficient slope	3	Enough space without damaging the road	0	Due to the presence of the bridge	2	Ok, enough space but needs to be integrated in bridge planning	needed for maintenance operation. The higher the bypass capacity, the better. Inflow (likely needs barrier in the river) and remaining waterlevel are important
Costs	1	Since the cross section is wide, high costs are expected	2	narrow section but ramp for maintenance needed	3	Lower costs are expected as a consequence of the little amount of work	0	New bridge => high cost but truck based maintenance reduces continuous costs	to a big extent a function of river width
<b>Score</b>	<b>23</b>		<b>27</b>		<b>25</b>		<b>31</b>		

# Configurazione scelta

## Selected configuration

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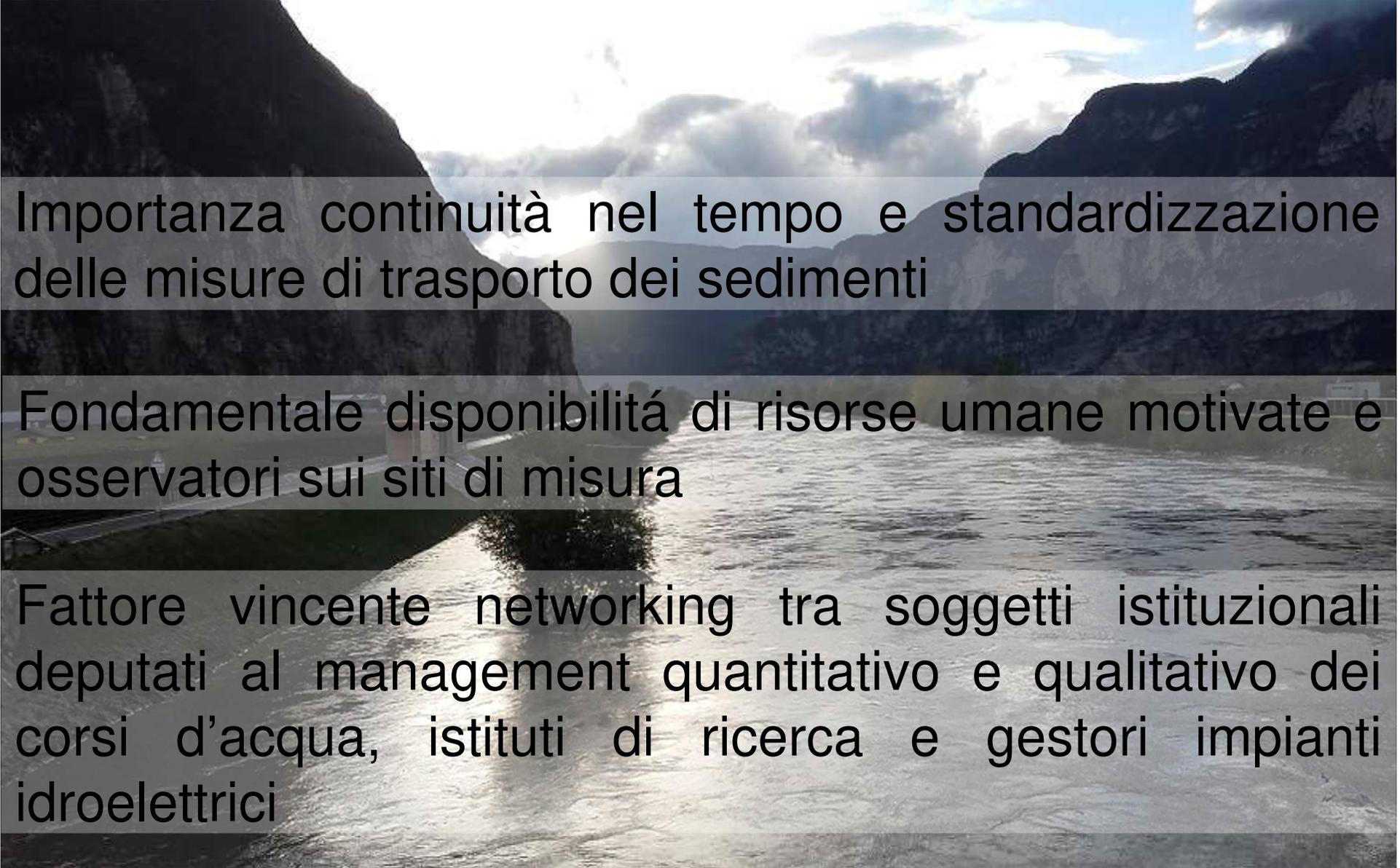
-  Locale di servizio / magazzino
-  Teleferica idrometrica
-  Soglia di fondo
-  Piastre geofoniche di tipo svizzero

-  Trappole sedimento
-  Carro ponte
-  Torbidimetro / Sonda di pressione e temperatura
-  Sensore Radar

## Note conclusive

### Final remarks

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Importanza continuità nel tempo e standardizzazione delle misure di trasporto dei sedimenti

Fondamentale disponibilità di risorse umane motivate e osservatori sui siti di misura

Fattore vincente networking tra soggetti istituzionali deputati al management quantitativo e qualitativo dei corsi d'acqua, istituti di ricerca e gestori impianti idroelettrici



Grazie a  
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Silvia Simoni, Gianluca Vignoli e Helmut Habersack

**Grazie per l'attenzione**