The HyMoCARES project: improving hydromorphological management of alluvial rivers

Andrea Goltara – Italian Centre for River Restoration (CIRF)

Workshop on Implementation of
Nature-based Solutions to tackle climate change

Marseille (France)
22-24 January 2019

Interreg Alpine Space

EUROPEAN UNION

HyMo CARES

HyMoCARES

HydroMorphological assessment and management at basin scale for the Conservation of Alpine Rivers and related Ecosystem Services

- Priority 3: **Liveable Alpine Space**
- Duration: **36** months (01.11.2016 - 30.10.2019)
- 13 **project partners** from 6 Alpine states

European Regional Development Fund

PROJECT SELECTED | FOR CO-FINANCING BY THE EUROPEAN UNION

Lead Partner
Bolzano Civil Protection Agency
Italy

Ticino Cantonal
River Management Agency
Suisse

Adige River District Authority
Italy

Institute for Water
of the Republic of Slovenia
Slovenia

Département des Hautes-Alpes
France

Autonomous Province
of Trento
Italy

Federal Agency for
Water Management
Austria

HyMo
CARES

Bavarian Fishery Association
Germany

Italian Centre
for River Restoration
Italy

Forschungsverbund
Berlin e.V.
Germany

National Research Institute of Science and Technology forEnvironment and Agriculture
France

University of Natural Resources
and Life Sciences, Vienna
Austria

ETH Zurich
Suisse

The ES framework

Management/ restoration measures

Biophysical processes and functions

Ecosystem services

BENEFITS

Interreg Alpine Space

EUROPEAN UNION

HyMo CARES

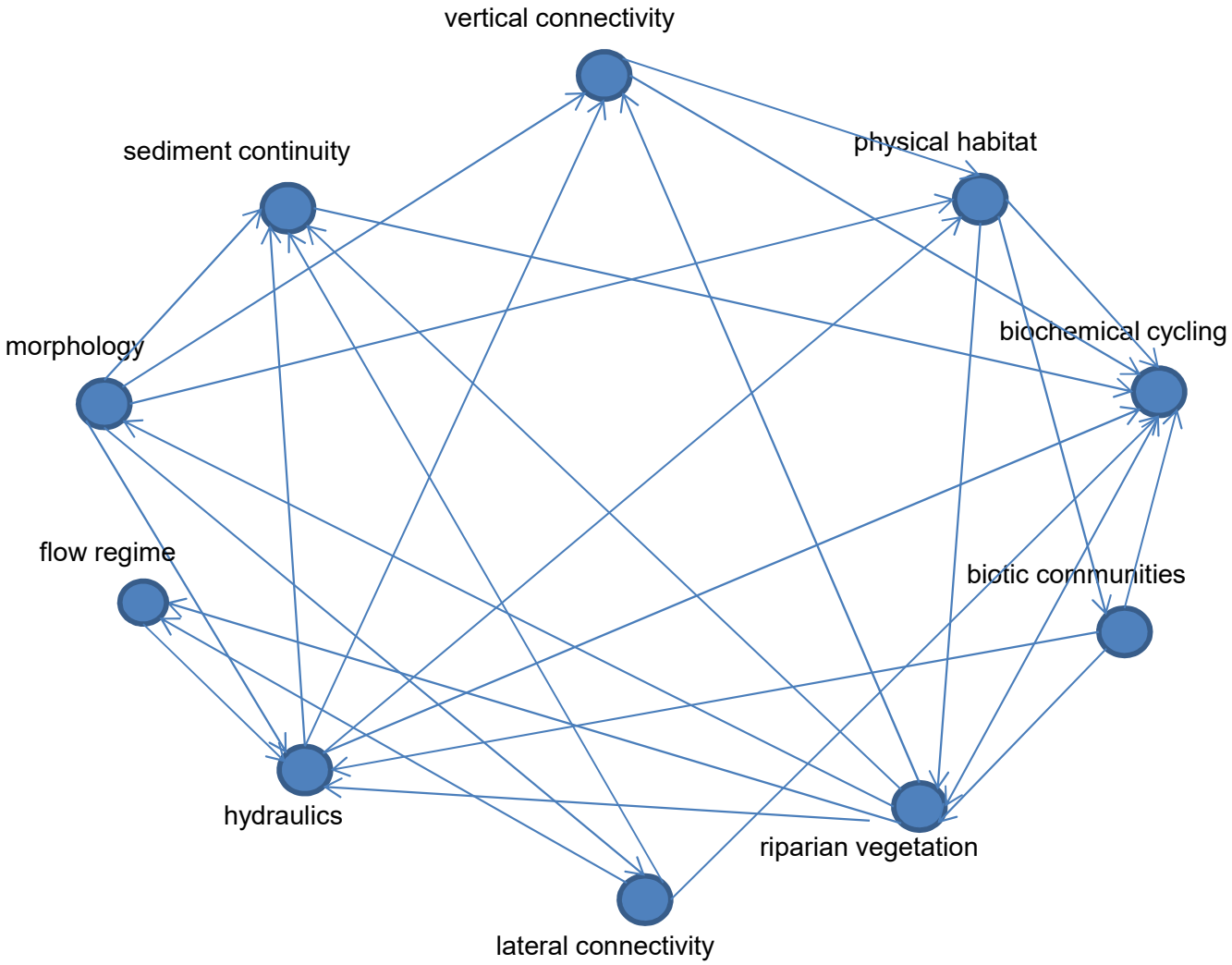
Weir removal

Sediment recharge/ restoration of sediment continuity

Removal of bank protection

Removal/ retreat of levees

...

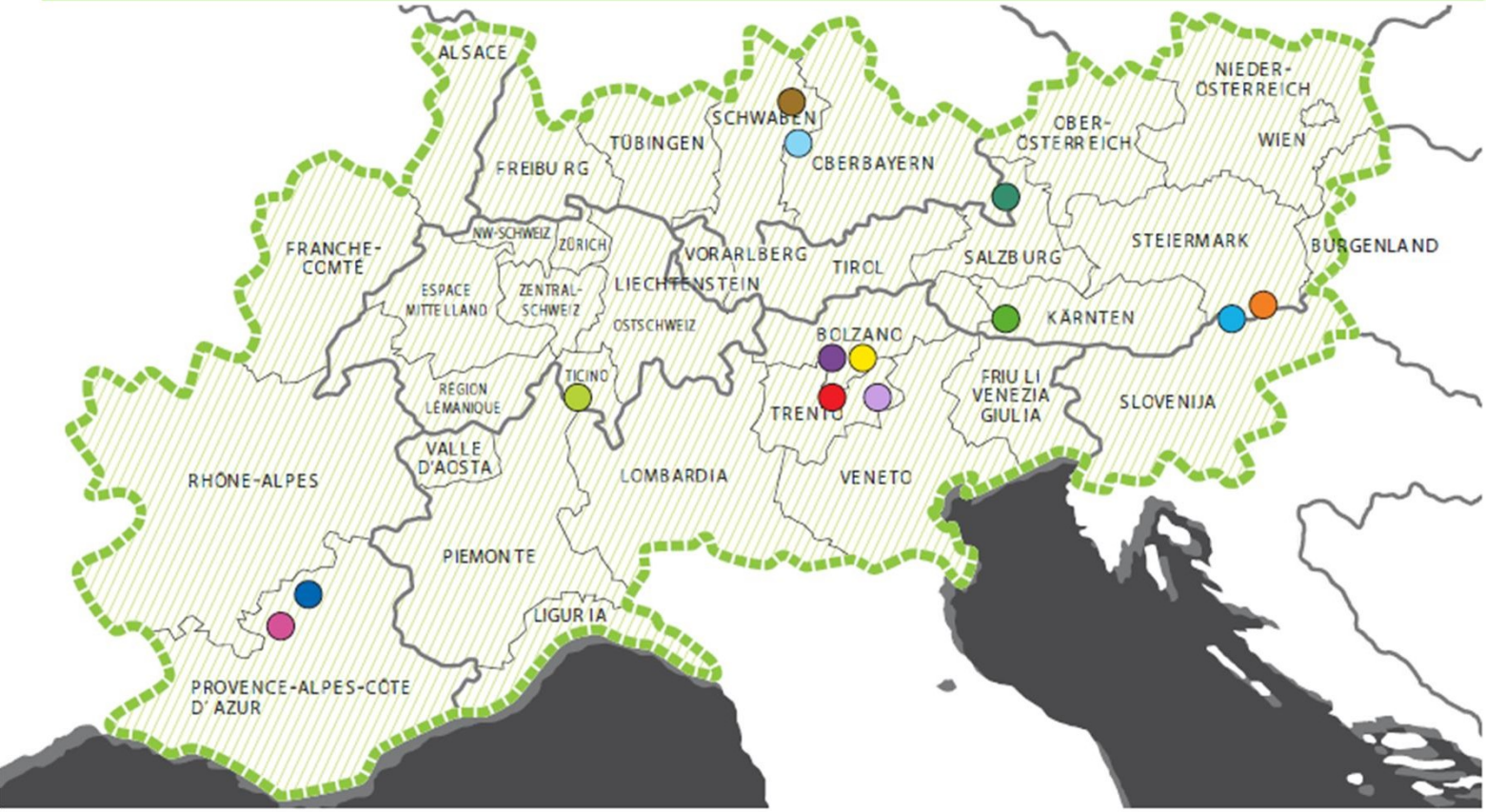


- Cultivated crops
- Surface water for drinking/non drinking uses
- Groundwater for drinking/non drinking uses
- Retention of nutrients
- Reduction of GHG
- Flood risk mitigation
- Drought risk mitigation
- Habitat related services
- Regulating T
- Education/science
- Aesthetics of landscape
- Water related activities
- Natural and cultural heritage
- Sediments (for construction)
- Hydropower
- Ecological status

Interreg
Alpine Space

EUROPEAN UNION

HyMo
CARES



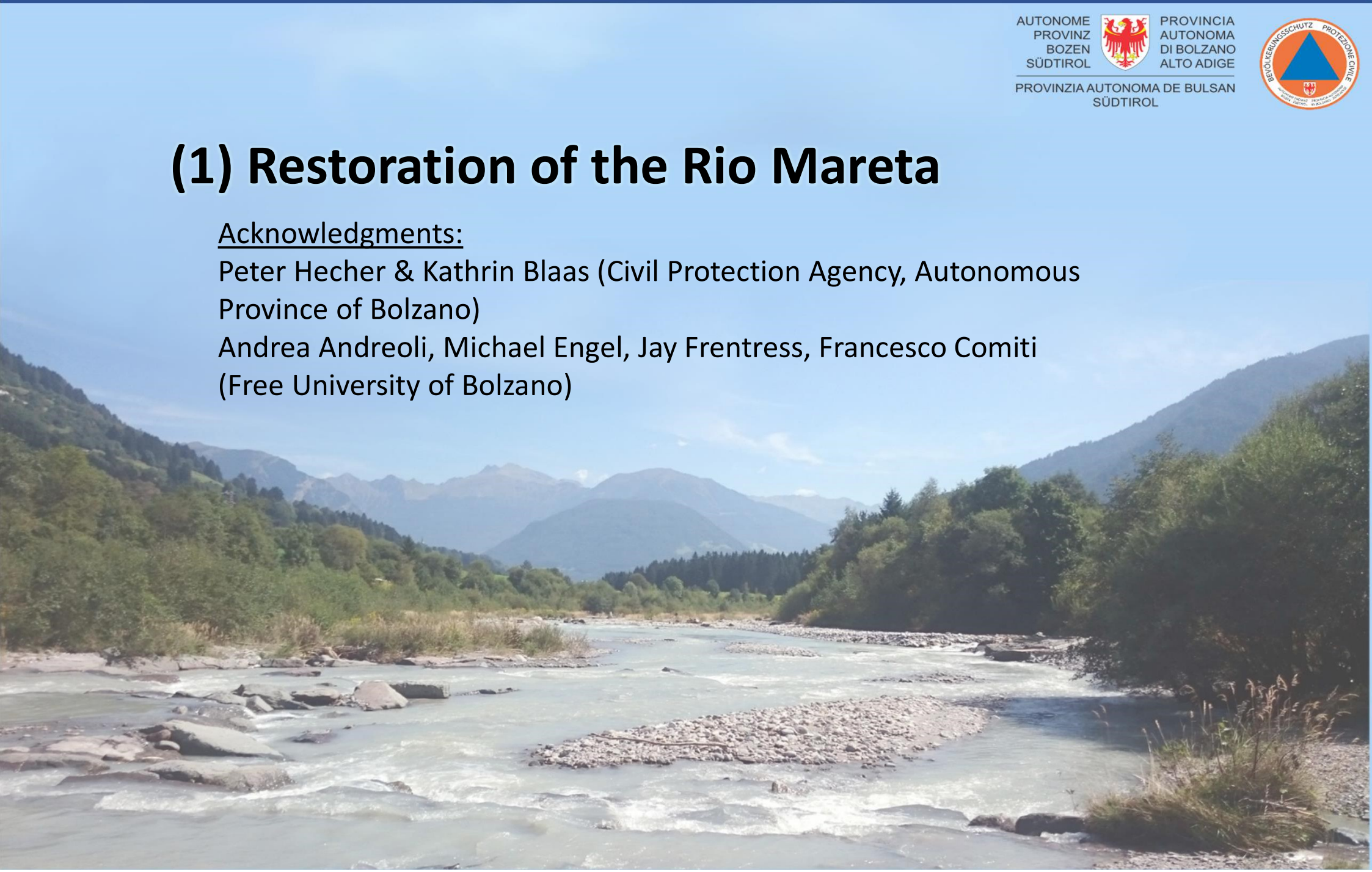
13 CASE STUDIES

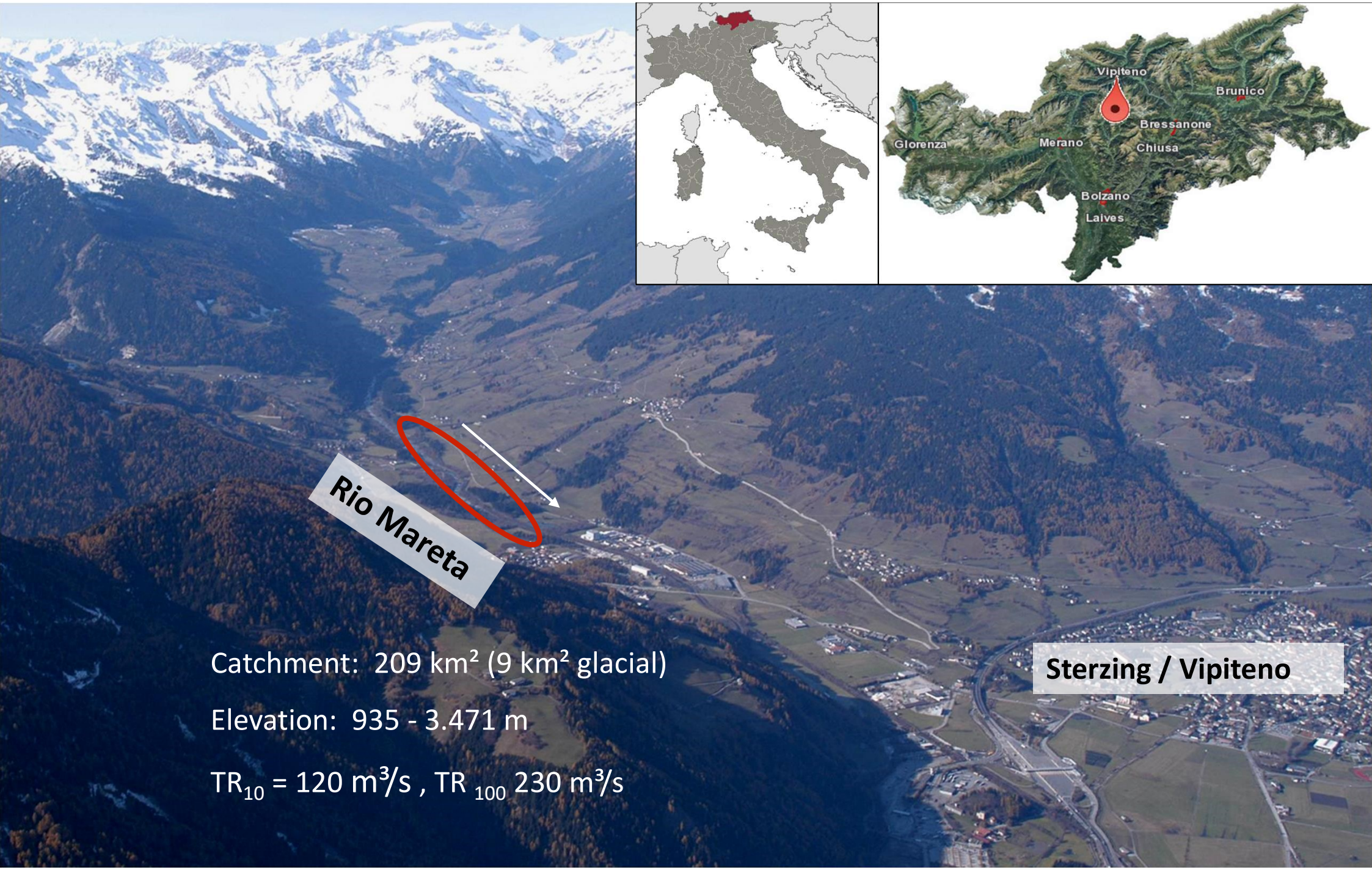
- BUECH
- DRAC
- MAGGIA
- ADIGE
- AVISIO
- ISARCO
- TALVERA
- WERTACH
- LECH
- DRAU
- DRAVA
- MUR
- SALZACH
- ALPINE SPACE COOPERATION AREA

AUTONOME PROVINZ BOZEN SÜDTIROL
PROVINCIA AUTONOMA DI BOLZANO ALTO ADIGE
PROVINZIA AUTONOMA DE BULSAN SÜDTIROL

(1) Restoration of the Rio Mareta

Acknowledgments:
Peter Hecher & Kathrin Blaas (Civil Protection Agency, Autonomous Province of Bolzano)
Andrea Andreoli, Michael Engel, Jay Frentress, Francesco Comiti (Free University of Bolzano)





Catchment: 209 km² (9 km² glacial)

Elevation: 935 - 3.471 m

TR_{10} = 120 m³/s , TR_{100} 230 m³/s

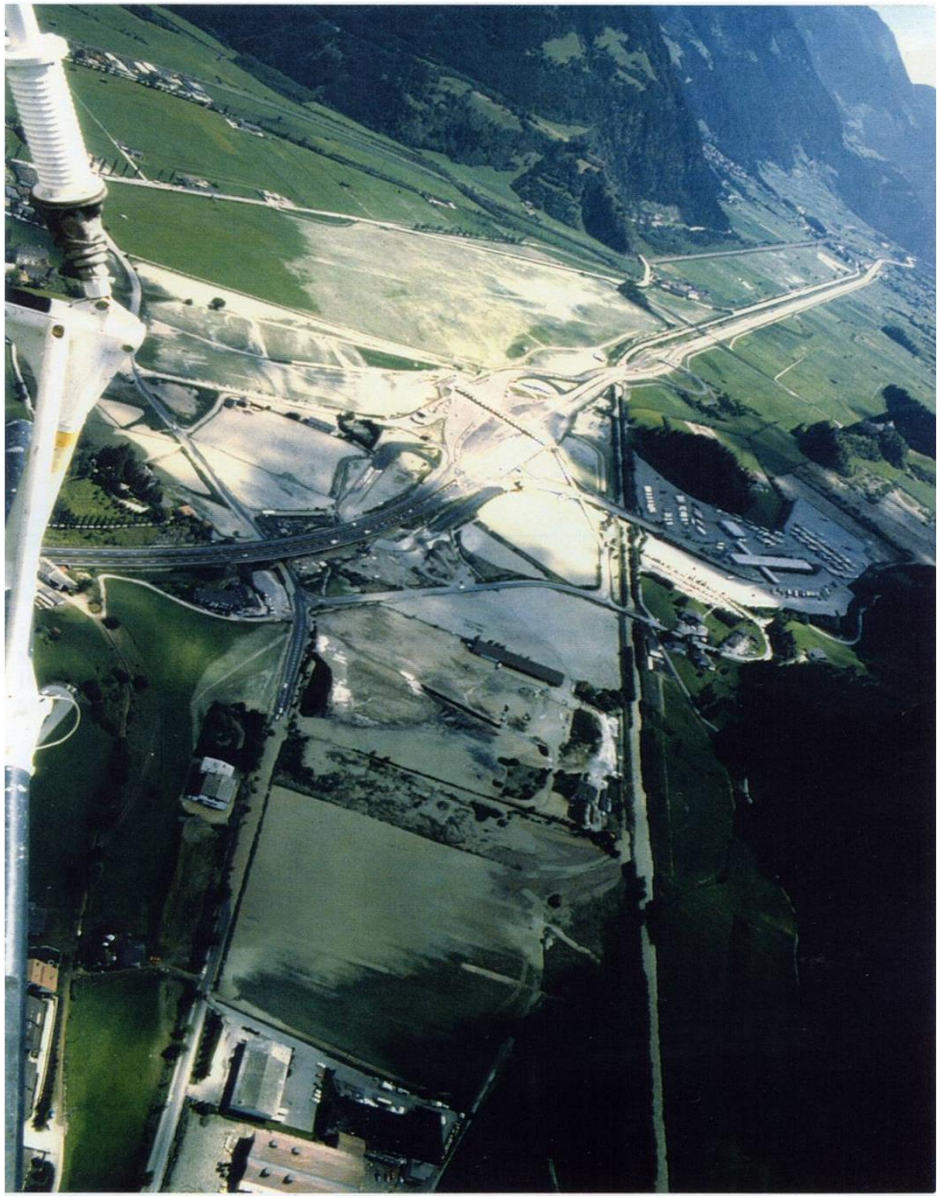
- **1980's: channelization**
- **Riverbed: braided → single channel**
- **Loss of longitudinal and lateral continuity**
- **Riverbed incision up to 8 m**

POOR ECOLOGICAL CONDITIONS

- **Lack of connectivity**
- **Lowering of the water table**
- **Loss of 88% of instream and riparian habitats**

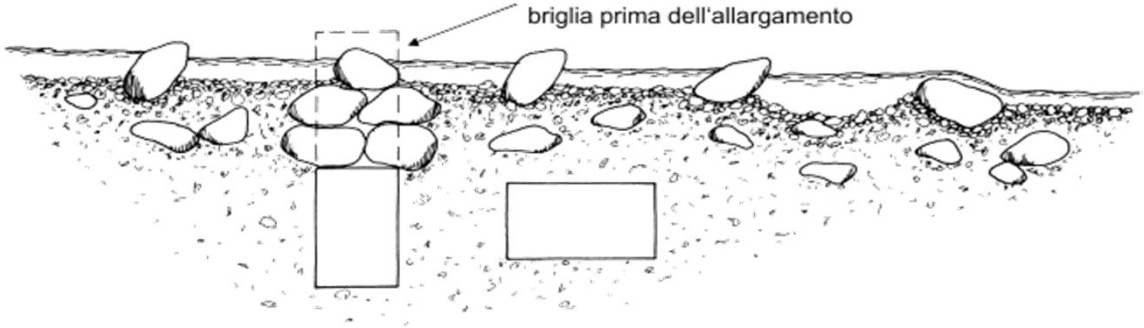
FLOOD RISK downstream

Vipiteno plain: 1985, **1987** (picture) and 1991



Works 2008-2010

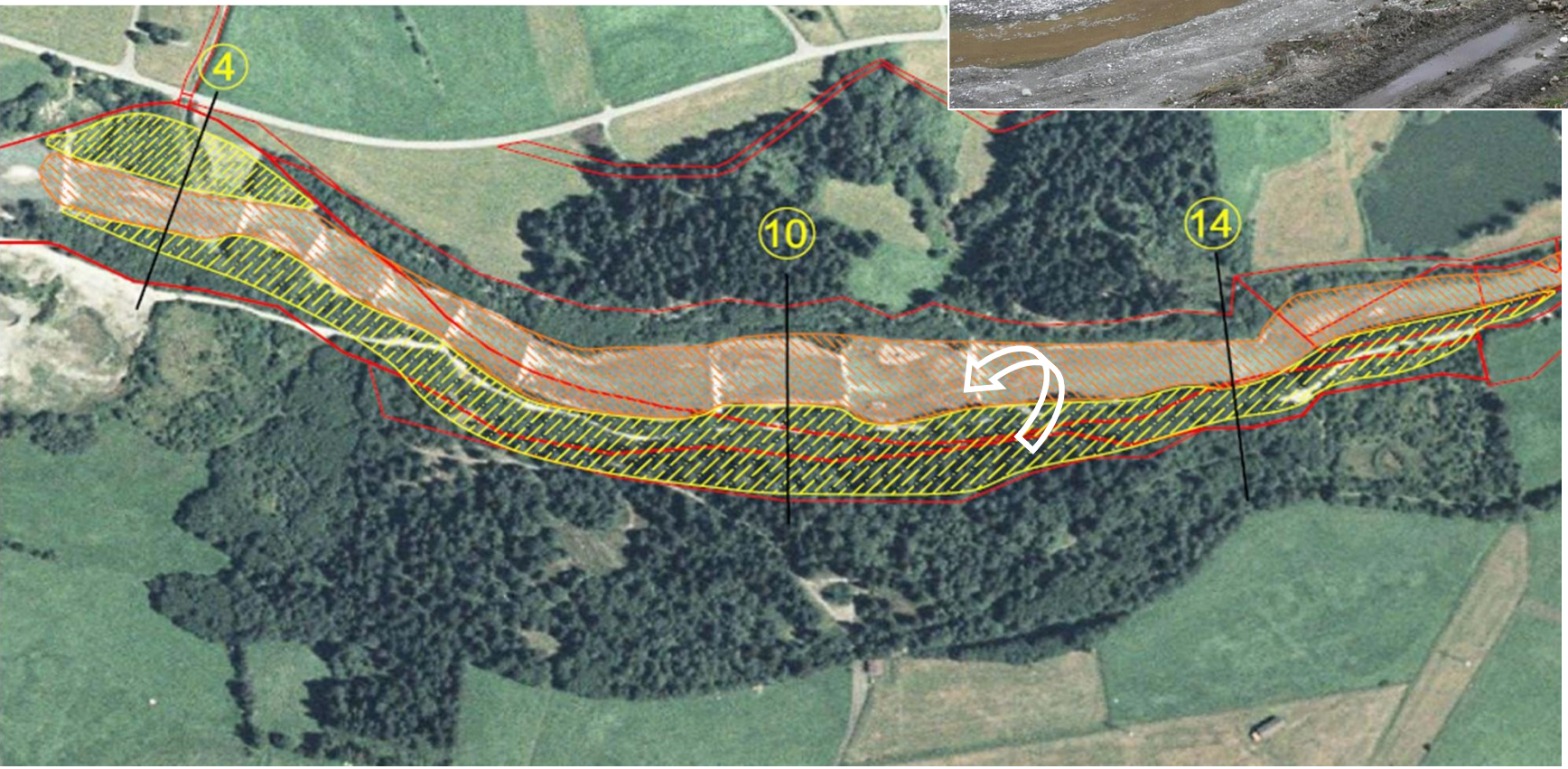
Demolition of 17 weirs, to restore longitudinal continuity



Clearcutting of 6,5 ha

Overall budget: 2,800,000 €

Riverbed enlargement
Reintroduction of 130.000 m³ of gravel (taken on site) to raise the riverbed.
Overall lenght of restoration approx. 2 km



Public domain
Excavation
Reintroduction

Morphological changes

Before the works

1 year after the works

8 years after the works

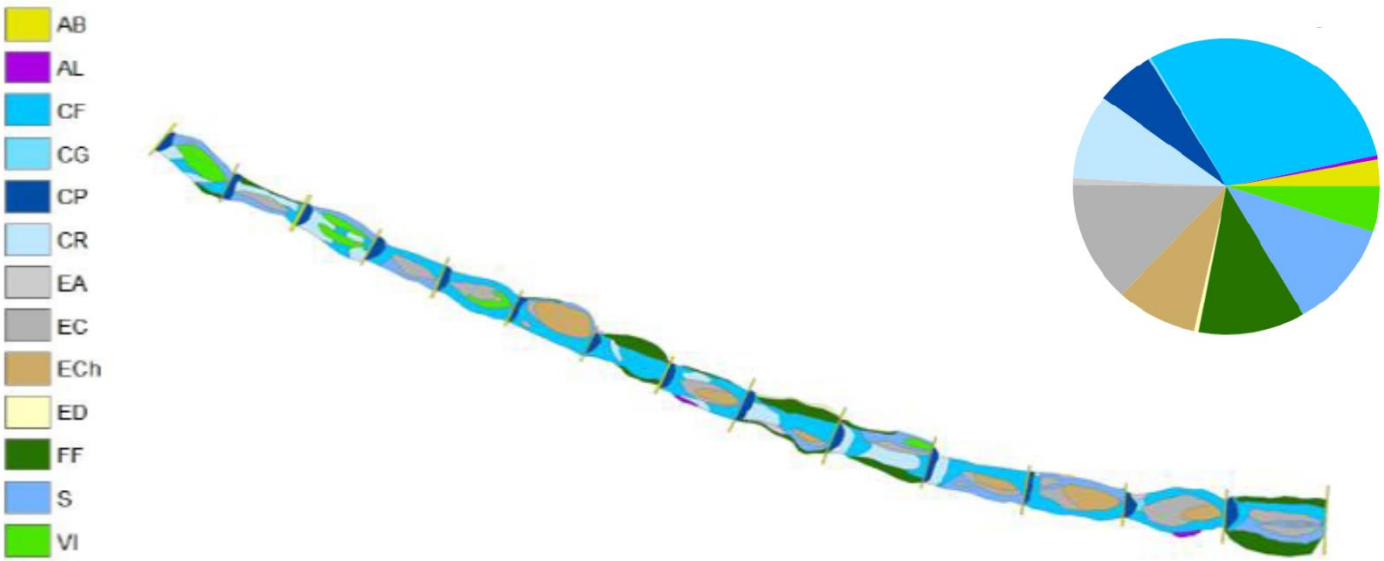
Braided, riverbed width doubled in comparison to pre-project conditions
(ensuring increased flood retention capacity)

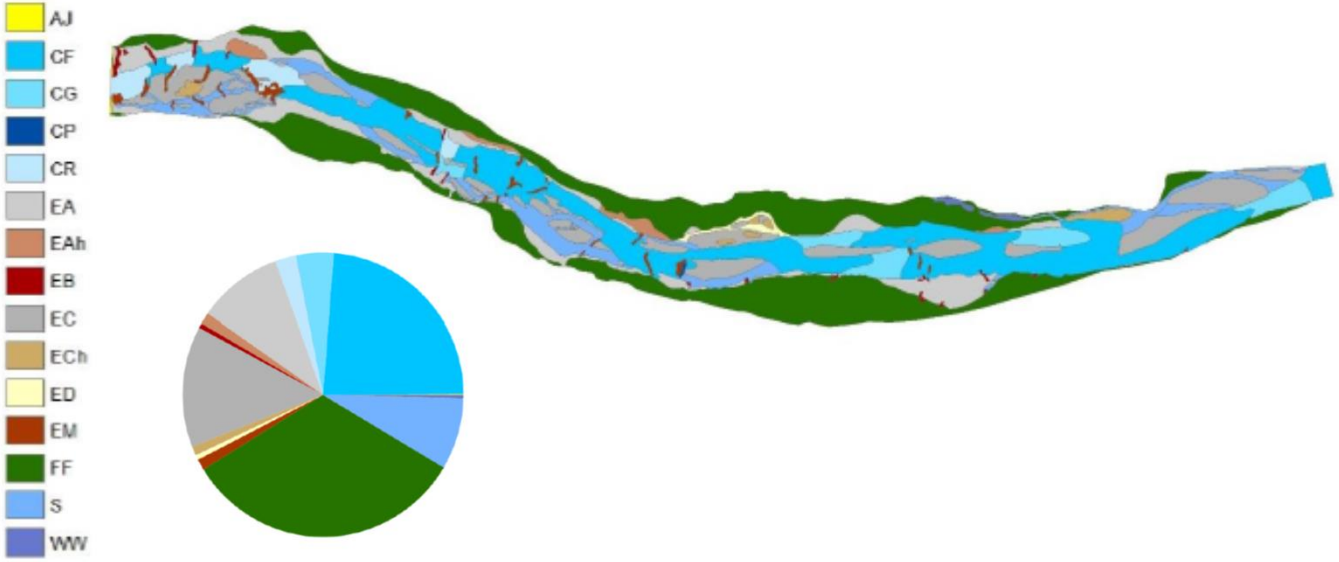
Ecological effects

Restoration of habitats linked to river dynamics (e.g. depositional habitats for *Myricaria germanica,* hystorically present in the site)

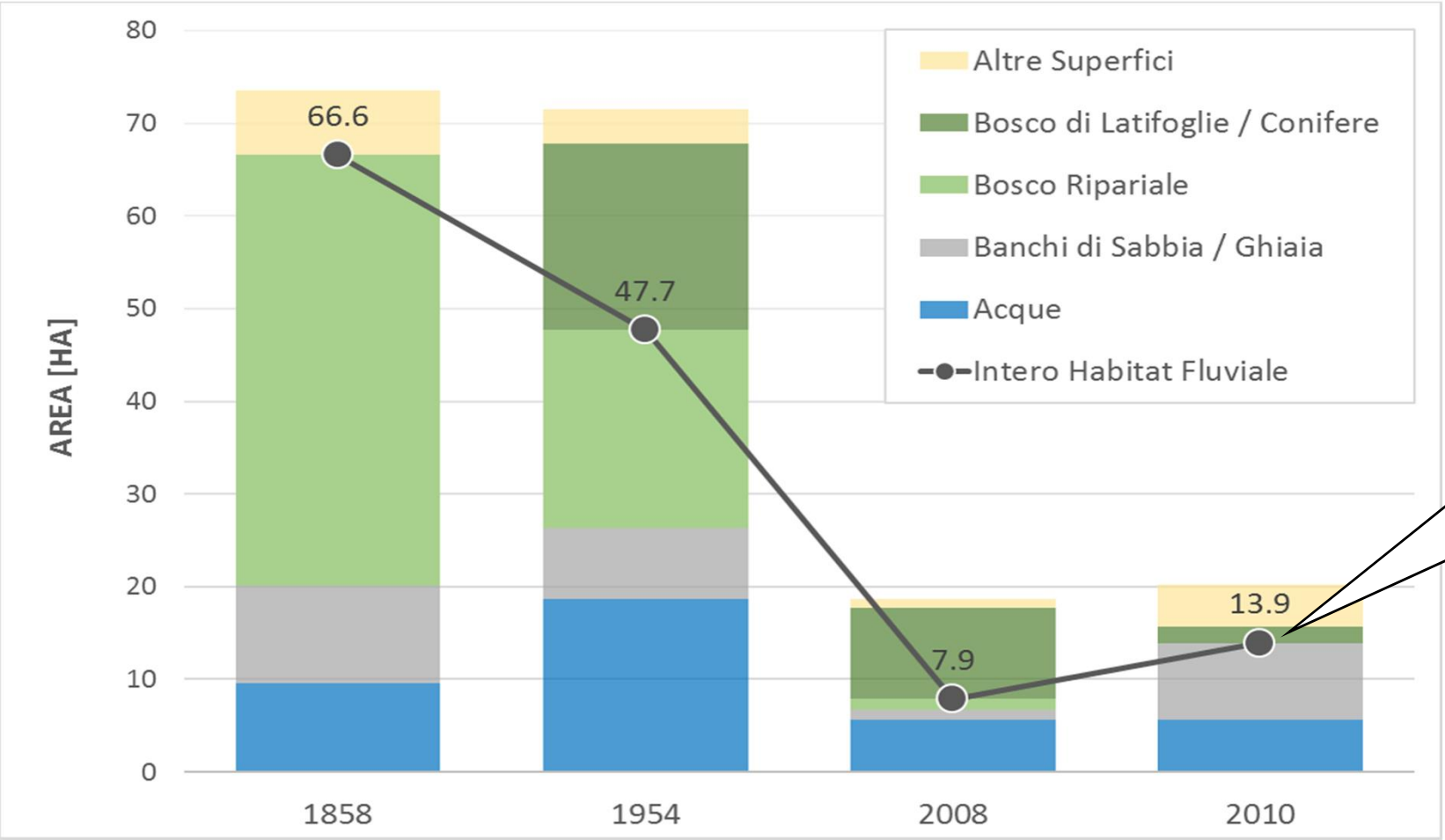
River habitats

Improvement of morphological quality and of habitats heterogeneity



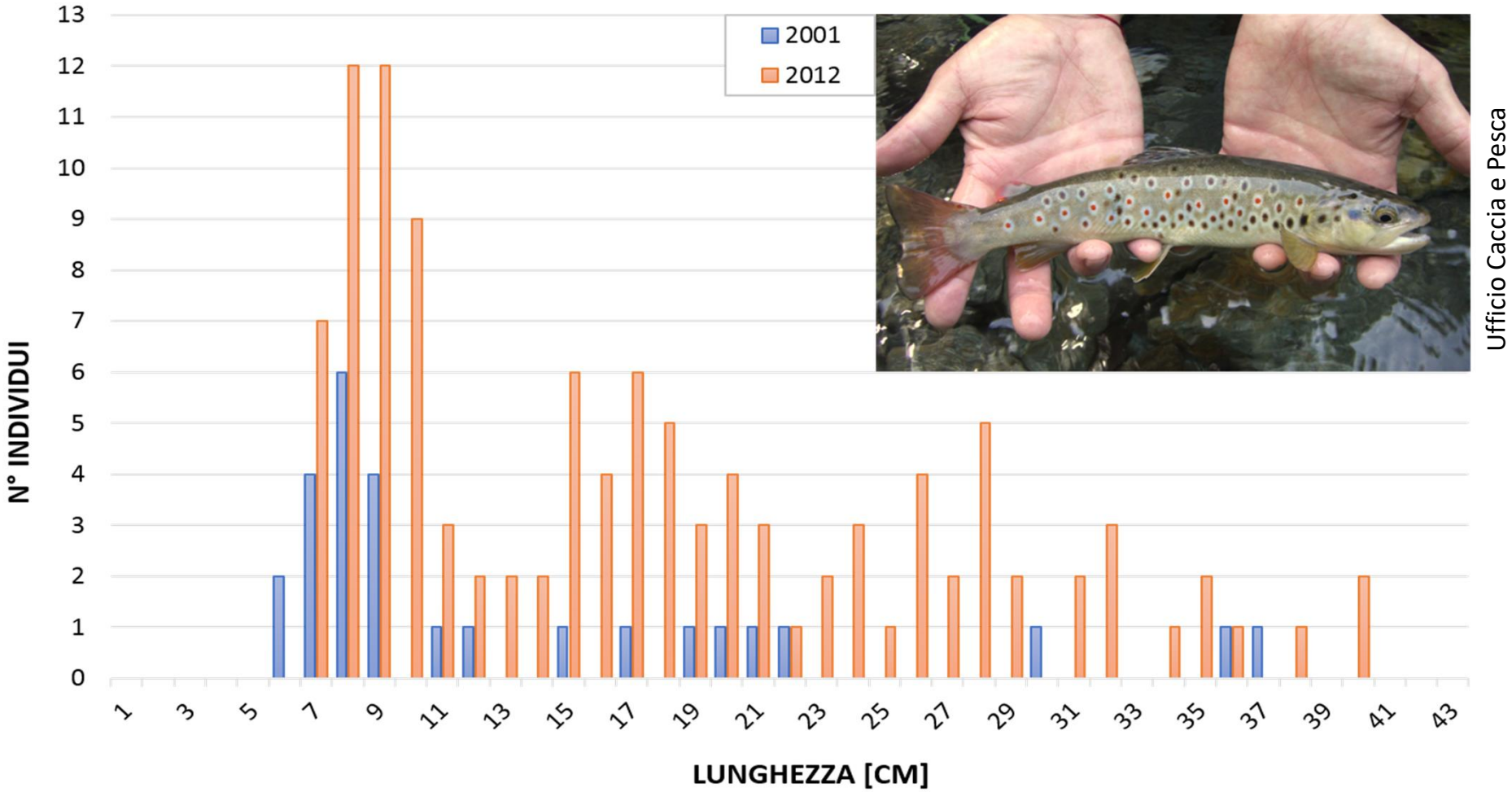


Riparian habitats



Increase of riparian habitats by 6 ha (Nössing & Kofler, 2012)

Positive effects of restoration of continuity and of morphological configuration and dynamics on the fish community



Natural reproduction of Salmo trutta

Increased recreational opportunities

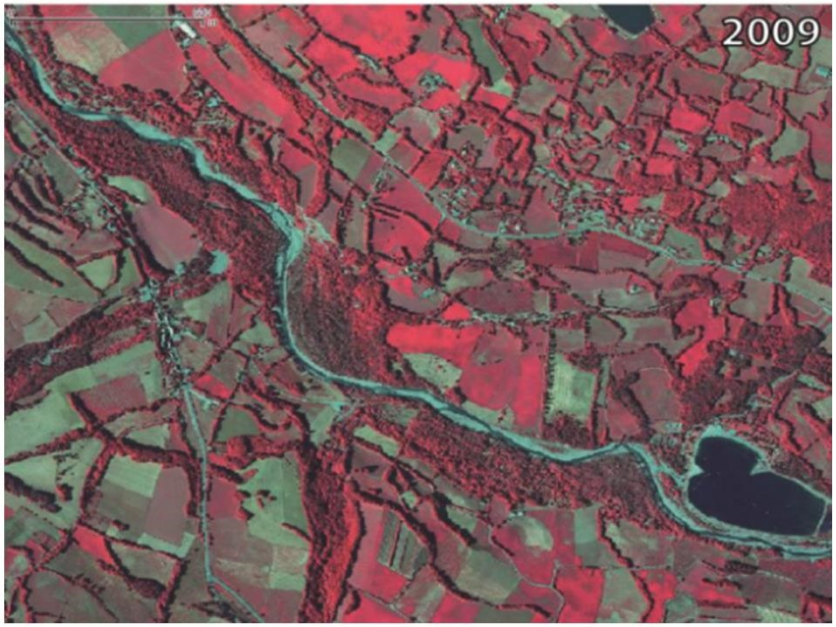
https://www.ratschings.info/media/bb2204b0-68bf-4bec-9597-cab371daf4ad/viae-vipiteno-2017.pdf

(2) Restoration of the river Drac

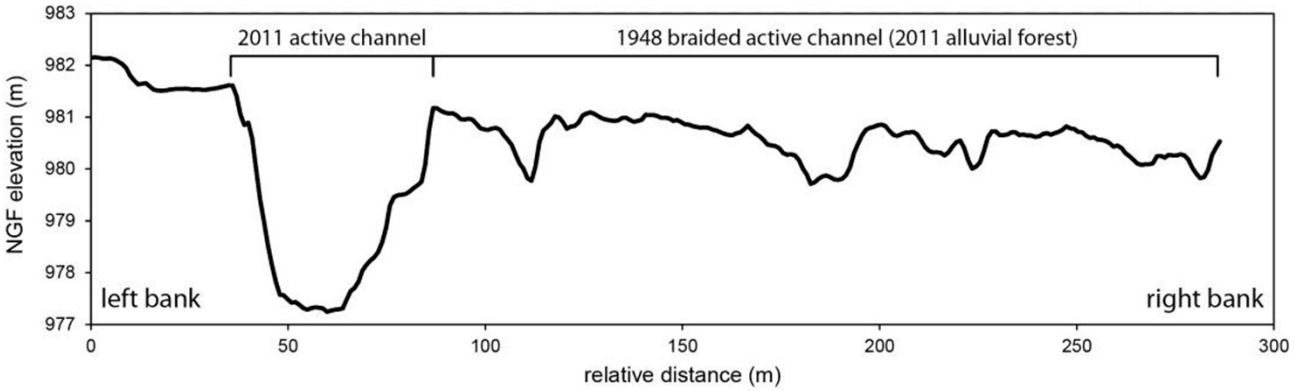
© CLEDA

Works funded and supervised by the Basin Authority (Agence de l'Eau RMC), the local basin authority (Communauté de Communes du Champsaur), the Hautes-Alpes department, the Région Rhône-Alpes; the EU. Total cost approx 5 M€

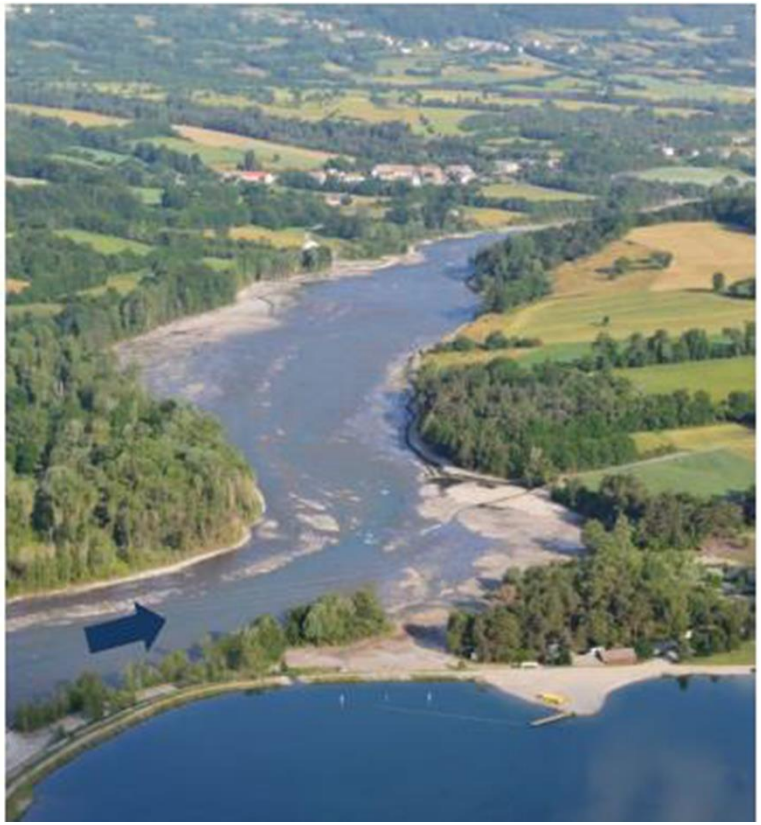
Acknowledgments:
Isabelle Chouquet, Romain Gaucher (Département des Hautes-Alpes), Fréderic Laval (BURGEAP), Fréderic Liébault & Mélanie Bertrand (IRSTEA), Gwenole Le Guellec (Maison Régionale de l'Eau)



- Massive extraction of sediments (15000 m3/y 1970-2012 just upstream the project stretch)
- Mobility corridor from 200 m in 1952 to 45 m max in 2012
- River style from braided to single channel
- Riverbed incision 2-4 m. reaching the clay layer, then quickly 4-5 m
- Regressive erosion, destablization/loss of functionality of protection works, high risk of collapse of the Champsaur dam
- Disconnection of tributaries
- Lowering of the water table
- Alluvial forest decline



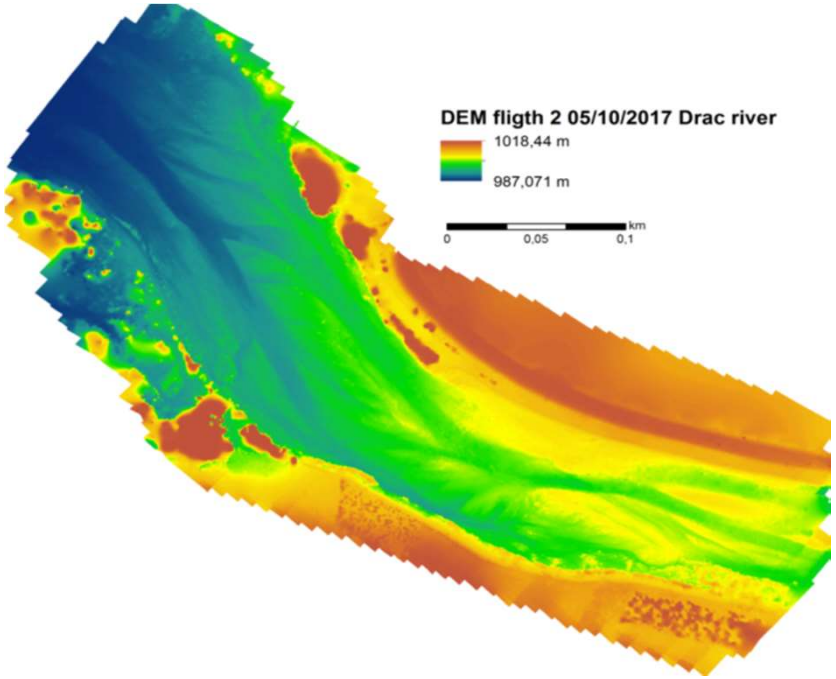
Restoration between November 2013 and April 2014



- **Largest single gravel reintroduction project in the EU: 450.000 m3 (390.000 from adjacent alluvial terraces, 60.000 transported from other sources, mainly tributaries)**
- **Creation of a new wide and shallow channel (100-m wide rectangular cross section, associated with a general rise of the bed-level), leaving the river free to recreate a braided morphology over a length of approx. 3.7 km**
- **1.65 m high grade-control weir built at the downstream end of the restored reach, with a fish pass and a canoe pass**

PHYSICAL MONITORING

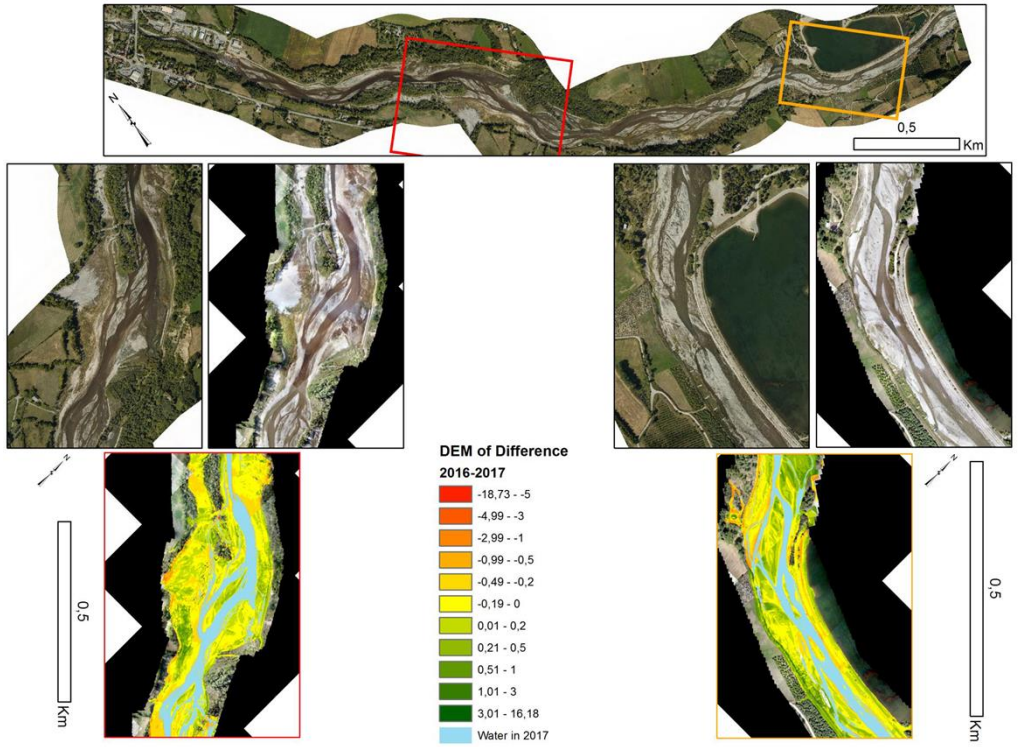
- Bedload tracing program using active ultra-high frequency RFID technology
- High-frequency qualitative survey of channel changes using timelapse cameras
- Repetitive high-resolution topographic surveys of the restored reach
- Ancillary field surveys for specific data analysis (e.g. bedload transport computation, calibration of imagery-based data processing)



MORPHOLOGICAL EFFECTS

First observations of the post-restoration channel evolution reveal a promising trend towards spontaneous braiding recovery

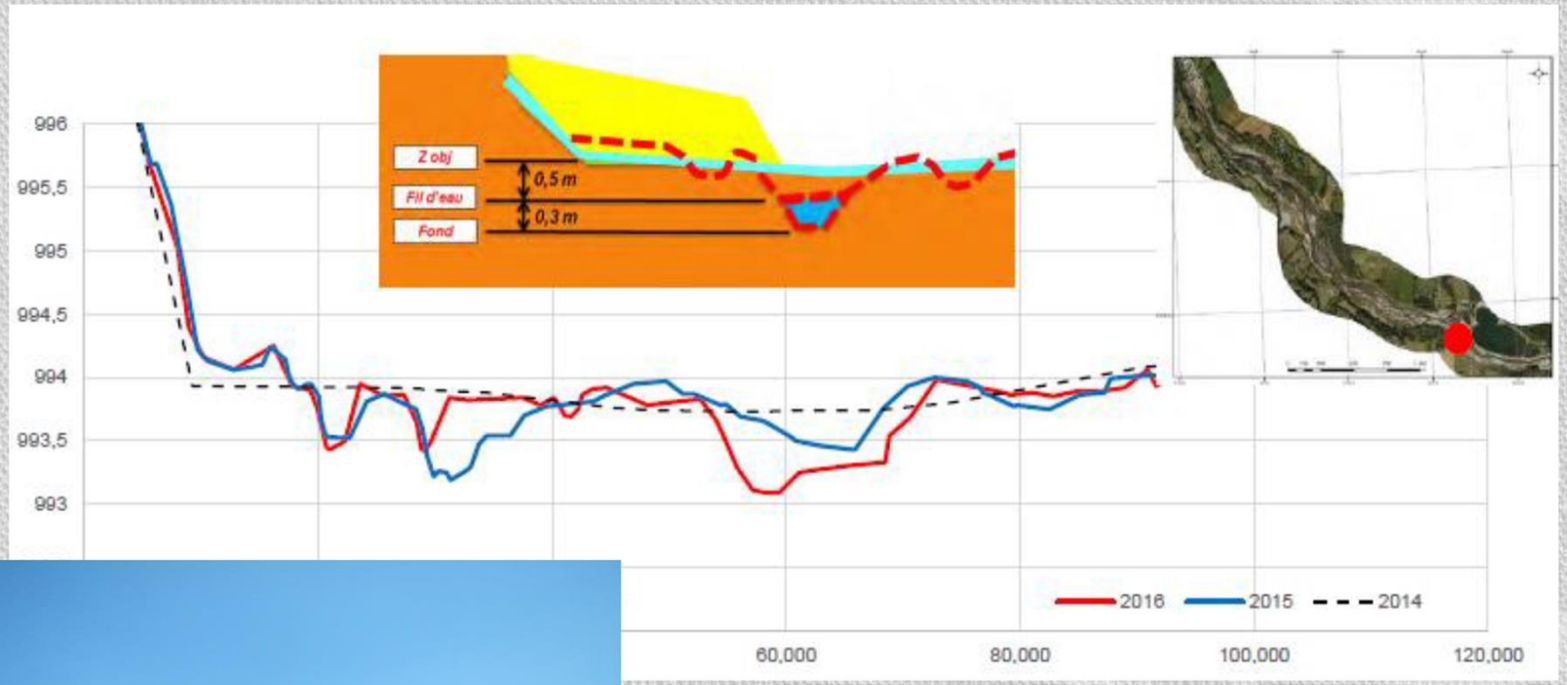
- The bedload tracing program shows a rapid transfer of gravel from the first upper sediment source of the restored reach (the braided Chabottes plain)



Orthophotographe (OPSIA, 2018, AERMC)

Post-restoration sediment remobilization

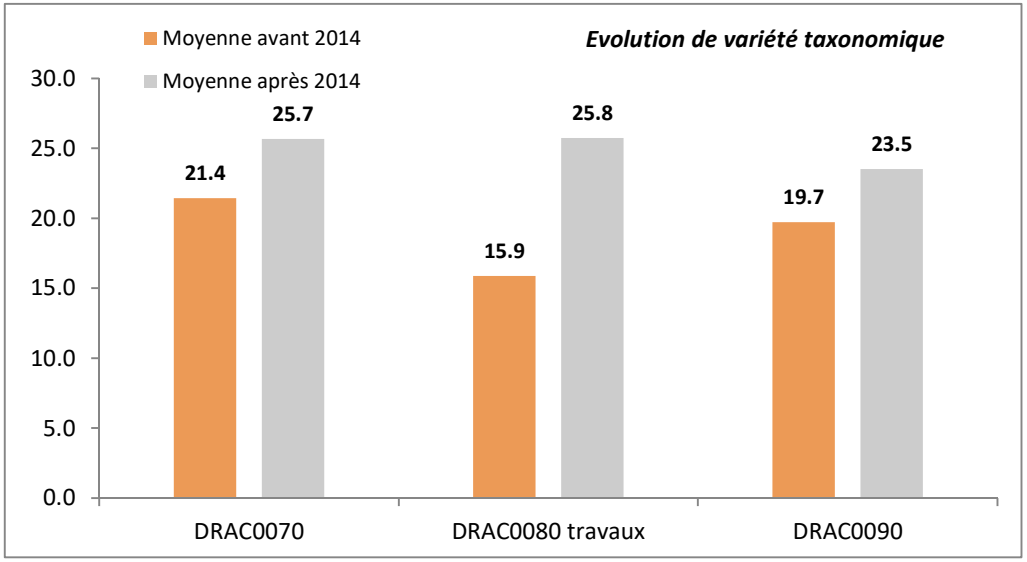
- Formation of channels on the upstream part of the restored reach

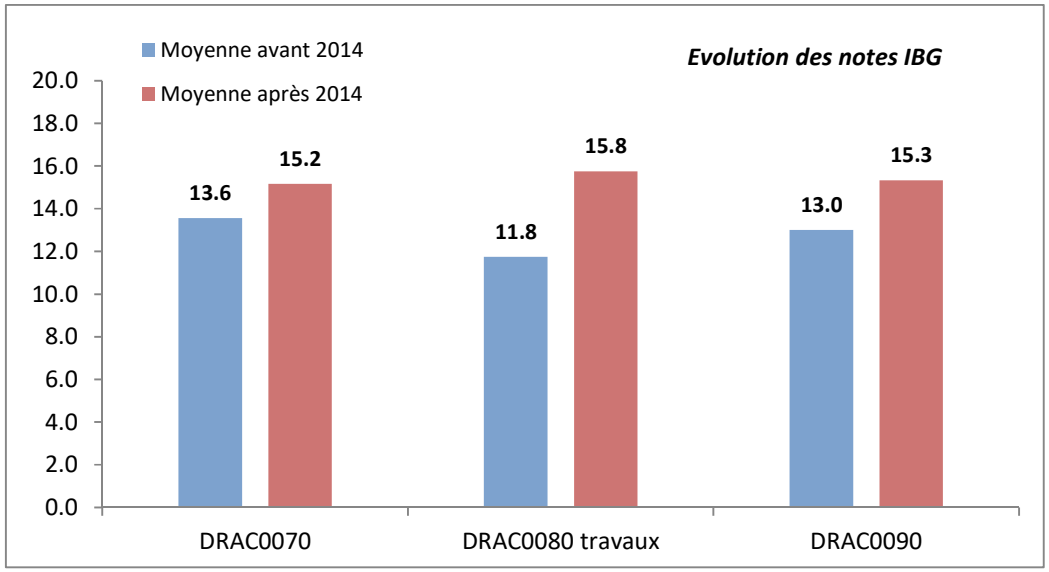


Laval et al. 2017 TSMR

EFFECTS ON BIOLOGICAL QUALITY

Benthic invertebrates





Overall increase of biological quality in the study reach (improved wastewater treatment?)

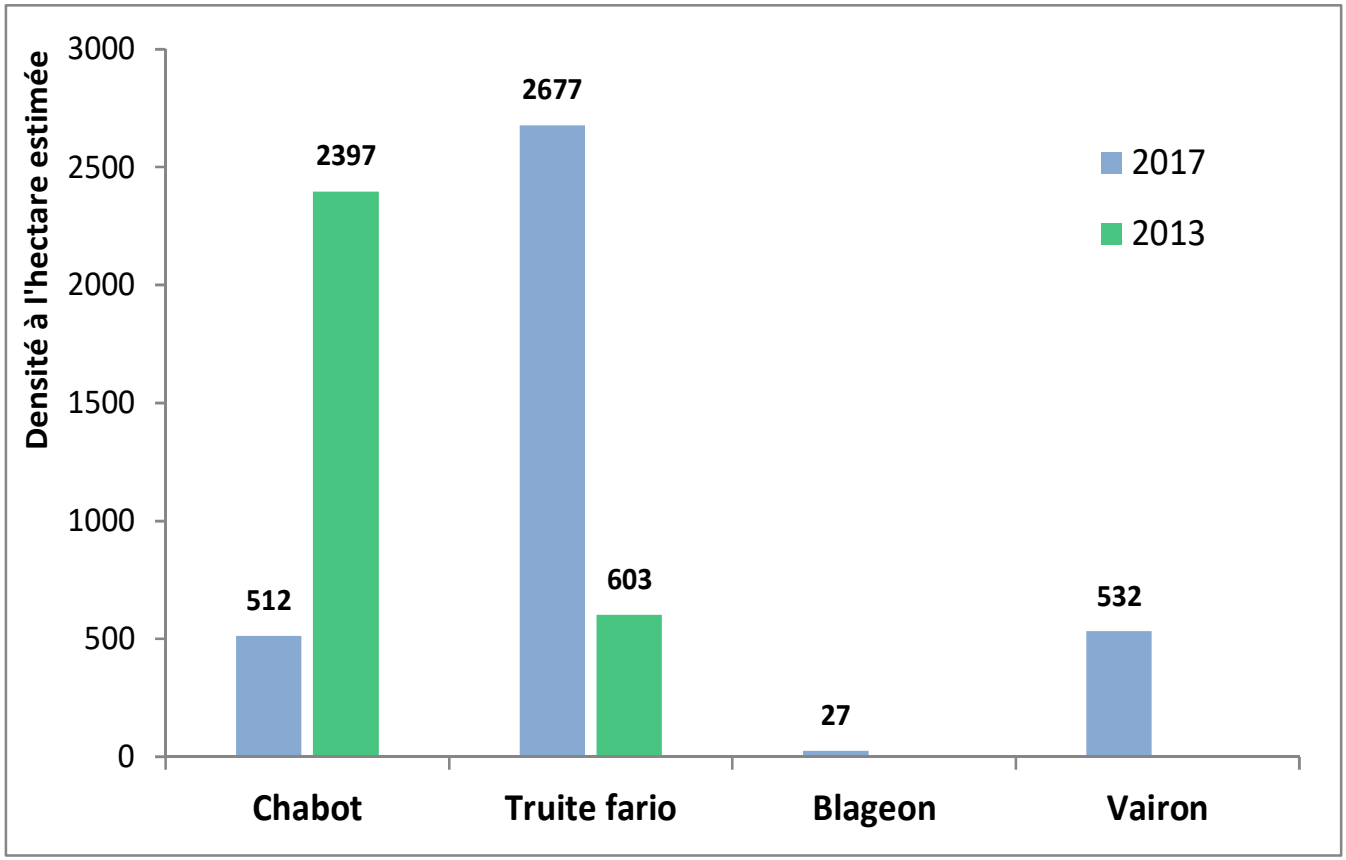
Clearer improvement in the restored reach (DRAC0080 travaux)

HER 1	Alpes internes	IBG
Classes d'état	Très bon	de 14 à 20
	Bon	de 11 à 13
	Passable	de 8 à 10
	Médiocre	de 5 à 7
	Mauvais	< 5

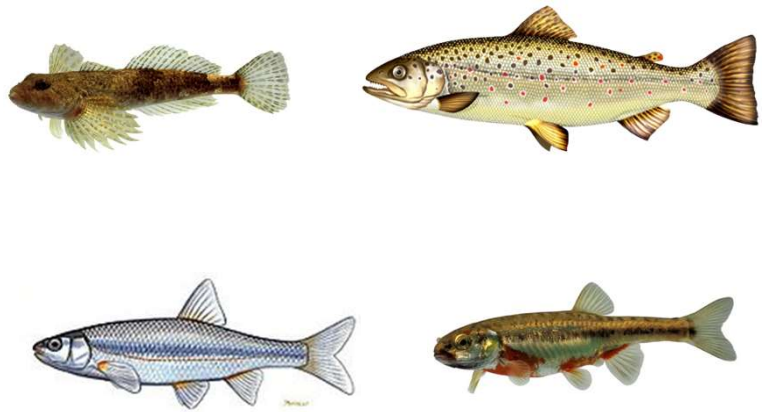
Tableau 9 : Seuils de qualification des classes d'état pour l'IBG DCE dans les Alpes internes (cas du Drac)

EFFECTS ON BIOLOGICAL QUALITY

Fish fauna

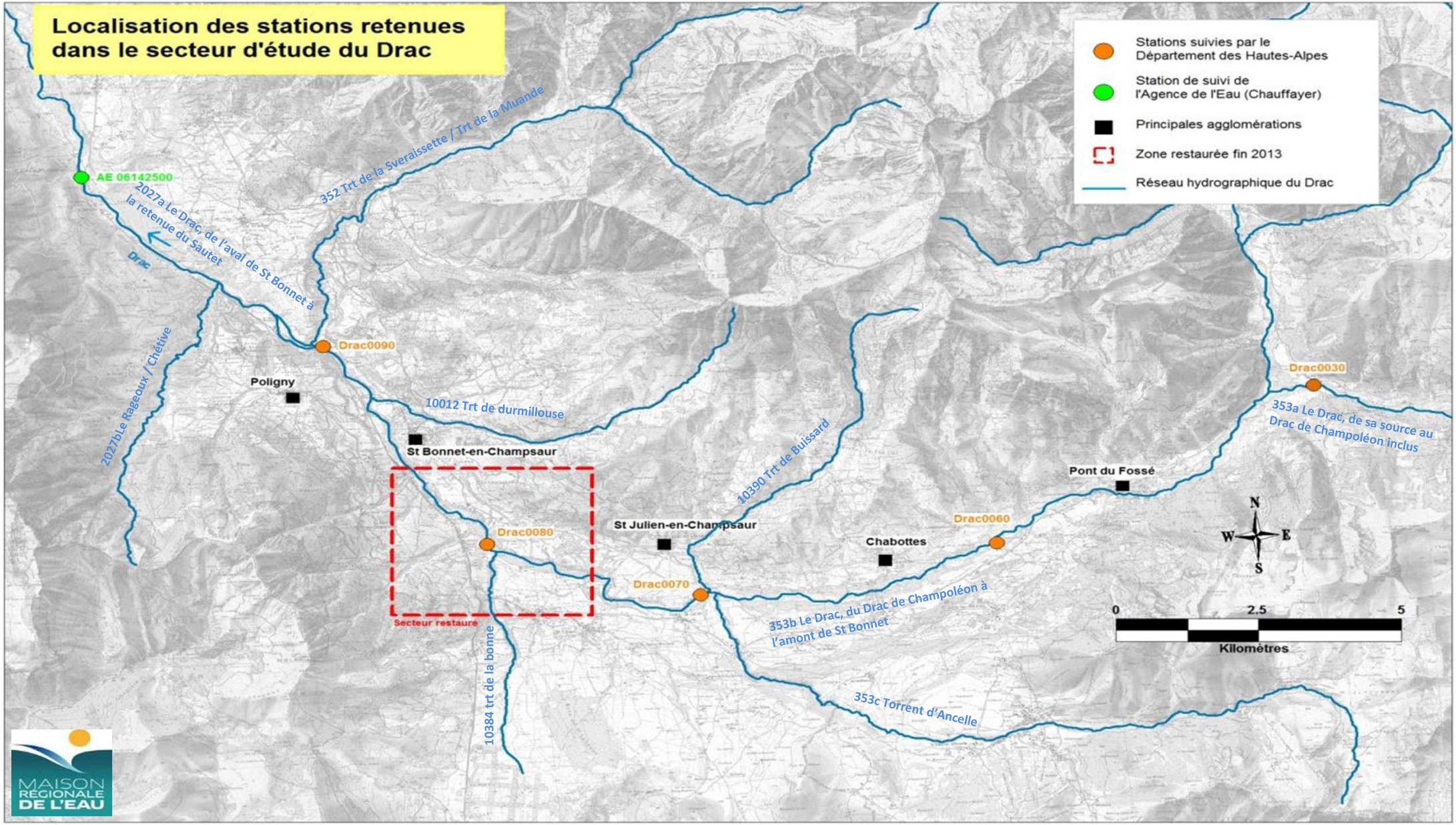


Fish population in 2013 (before restoration) and in 2017 (after restoration) in the restored reach, based on electrofishing by ONEMA



Now 4 species instead of 2 (2 more termophilic)

Brown trout significantly increased, but bullhead decreased


Localisation des stations retenues dans le secteur d'étude du Drac
Stations suivies par le Département des Hautes-Alpes
Station de suivi de l'Agence de l'Eau (Chauffayer)
Principales agglomérations
Zone restaurée fin 2013
Réseau hydrographique du Drac
AE 06142500
2027a Le Drac, de l'aval de St Bonnet à la retenue du Sautet
Drac
352 Trt de la Sveraissette / Trt de la Muande
Drac0090
Poligny
10012 Trt de durmillouse
St Bonnet-en-Champsaur
2027bLe Rageoux / Chétive
Drac0080
Secteur restaure
10384 trt de la bonne
St Julien-en-Champsaur
10390 Trt de Buissard
Drac0070
Chabottes
Drac0060
Pont du Fossé
Drac0030
353a Le Drac, de sa source au Drac de Champoléon inclus
353b Le Drac, du Drac de Champoléon à l'amont de St Bonnet
353c Torrent d'Ancelle
N
W
E
S
0
2.5
5
Kilomètres
MAISON REGIONALE DE L'EAU

(3) Restoring sediment continuity in the River Buëch (St Sauveur EDF hydropower plant)

Acknowledgments:
Rémi Loire (EDF Hydro Engineering Centre)

Human alterations of the physical fluvial corridor

- Gravel mining (3 Mm^3 - 6 Mm^3)
- River regulation (dykes)
- Saint Sauveur dam (1992)
- Bedload has been strongly impacted
- **Strong channel responses**
- Alluvial fan is aggrading upstream the reservoir (**flood risk**)
- Narrowing and degradation of the active channel with downstream propagation
- Marly bedrock outcrops are observed along the degraded reach
- A shift from a braided to a wandering pattern

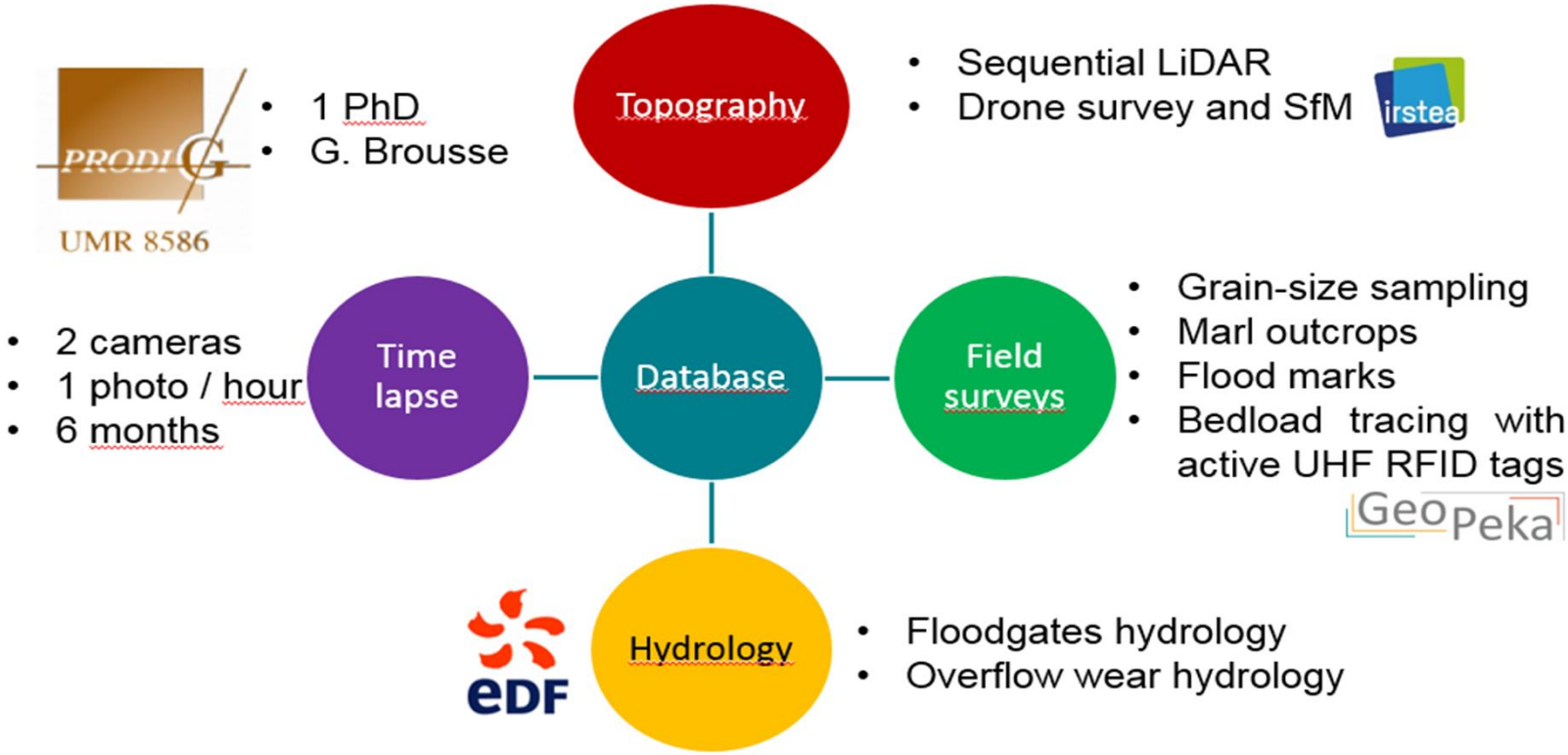
Restoration of sediment continuity

- **Flushing when Q > $Q_{threshold}$ before 2015: transparency for Q>80 m3/s (without forecast); from 2015 : transparency for Q>60 m3/s (according to forecast on 24h)**
- **Mechanical reintroduction of gravel dredged in the alluvial fan of the Saint-Sauveur reservoir. September 2016: 44.000 m3, 0,5 M€**

Monitoring

Main objective: capture the geomorphological response of the degraded reach to artificial gravel recharge

Monitoring piloted by G. Brousse (PhD student)



Just after the sediment replenishment

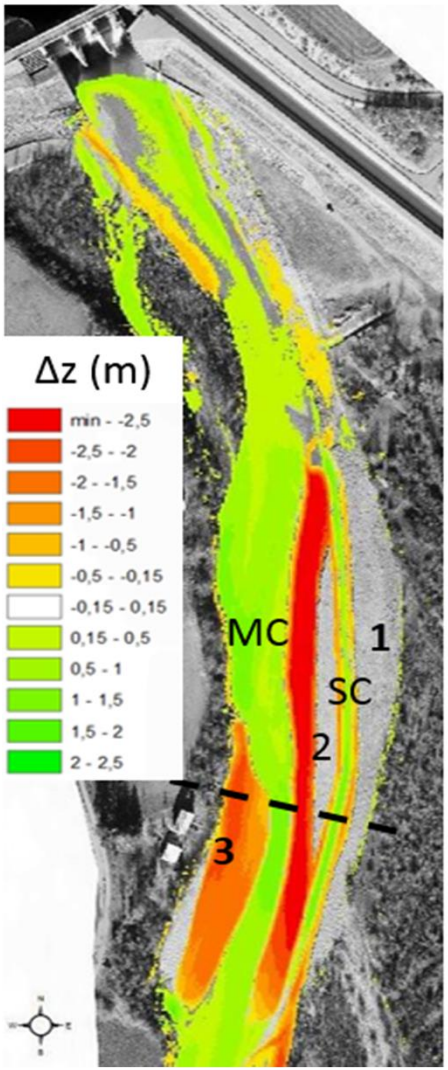
During the first flood (November 2016)

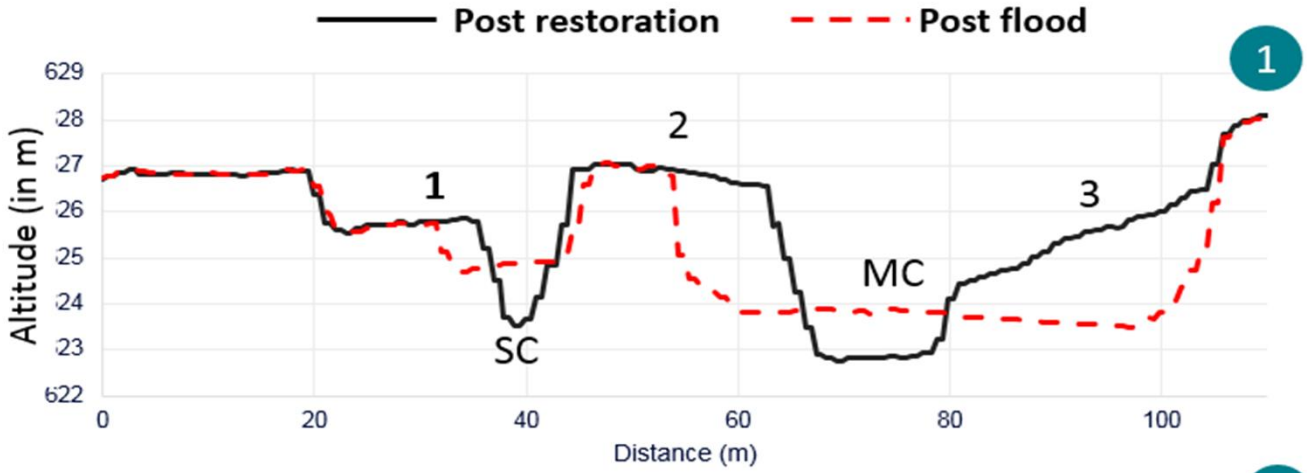
Berms erosion

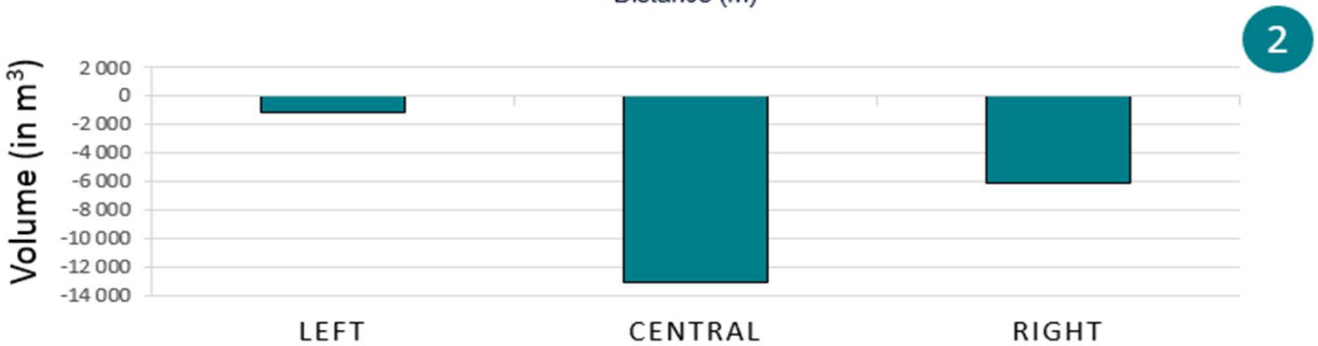
Hydraulic transparency

After the flood

Results : erosion and topographic response



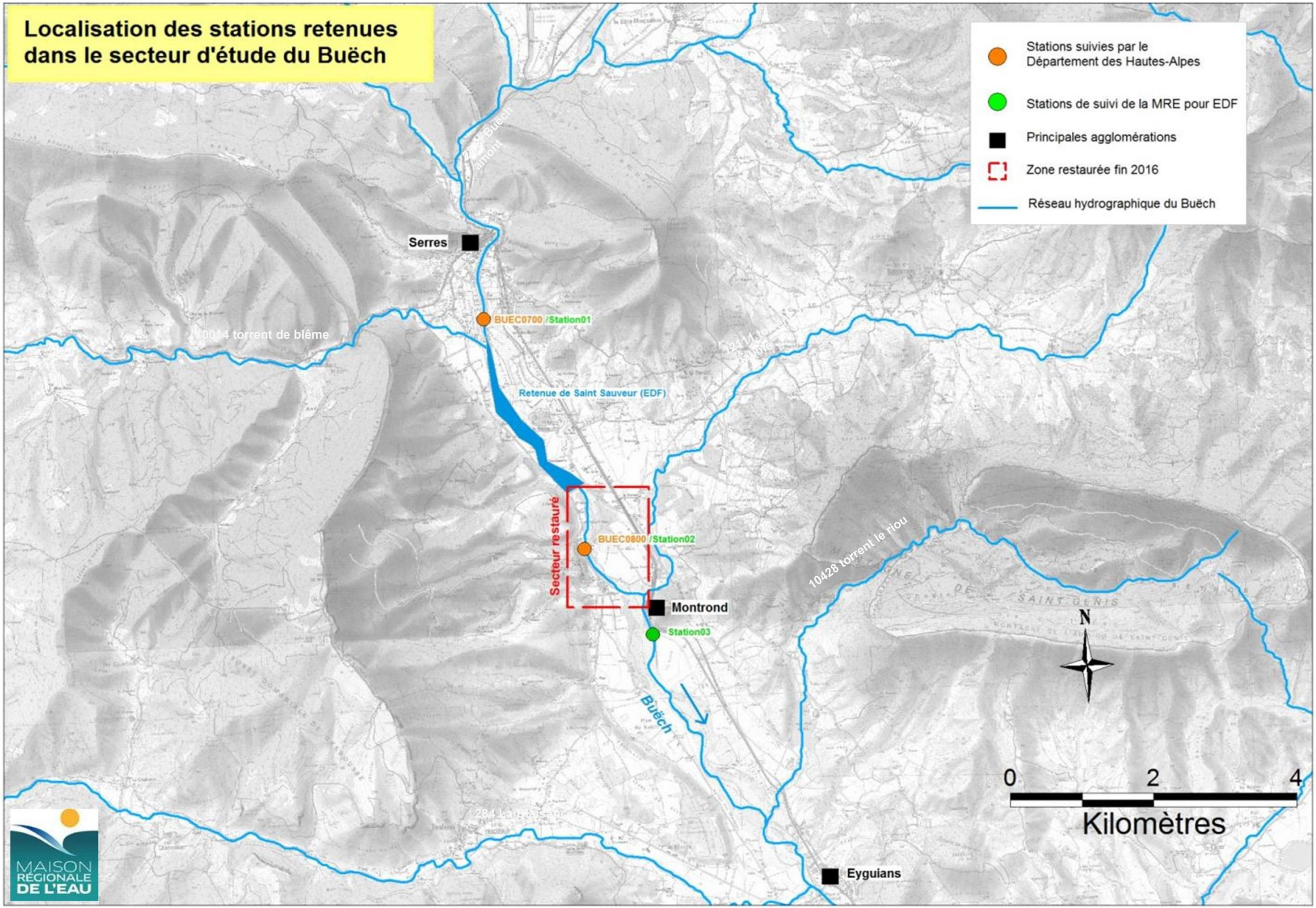




Very high erosion on the central and on the right berm during flood

➔ 20,000 m³ (46% of initial berms)

Net sediment budget ➔ -11,000 m³


Localisation des stations retenues dans le secteur d'étude du Buëch
Stations suivies par le Département des Hautes-Alpes
Stations de suivi de la MRE pour EDF
Principales agglomérations
Zone restaurée fin 2016
Réseau hydrographique du Buëch
Serres
BUEC0700 /Station01
0014 torrent de blême
Retenue de Saint Sauveur (EDF)
Secteur restauré
BUEC0800 /Station02
Montrond
Station03
10428 torrent le riou
Buëch
Eyguians
N
0
2
4
Kilomètres
MAISON RÉGIONALE DE L'EAU

Thank you

For more information:

a.goltara@cirf.org

www.alpine-space.eu/hymocares

Workshop on Implementation of
Nature-based Solutions to tackle climate change

Marseille (France)
22-24 January 2019