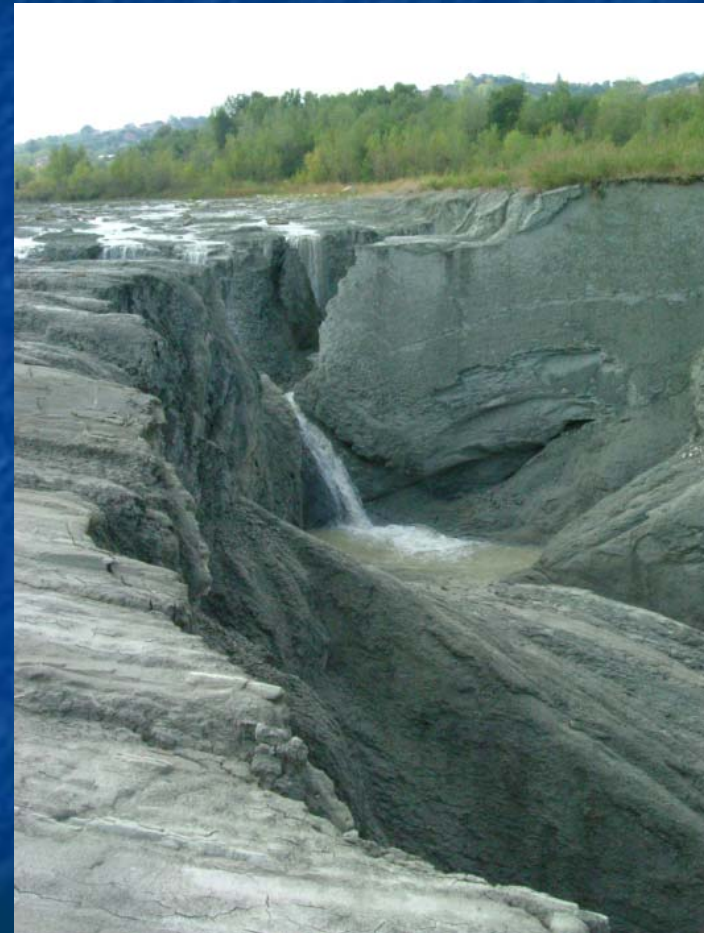


The Marecchia jump power project: coupling hydrogeologic hazard mitigation with hydropower development



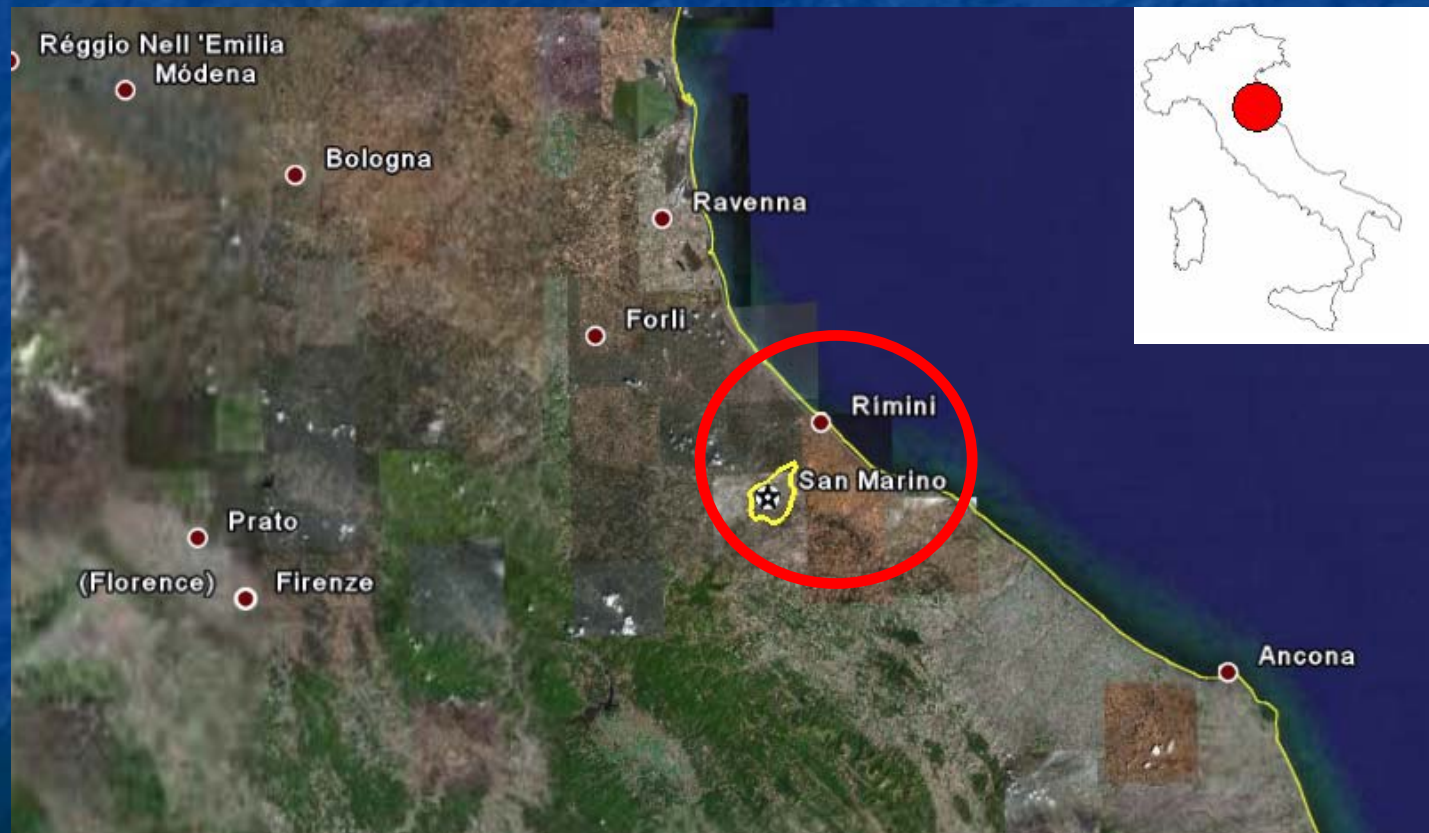
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General catchment characteristics

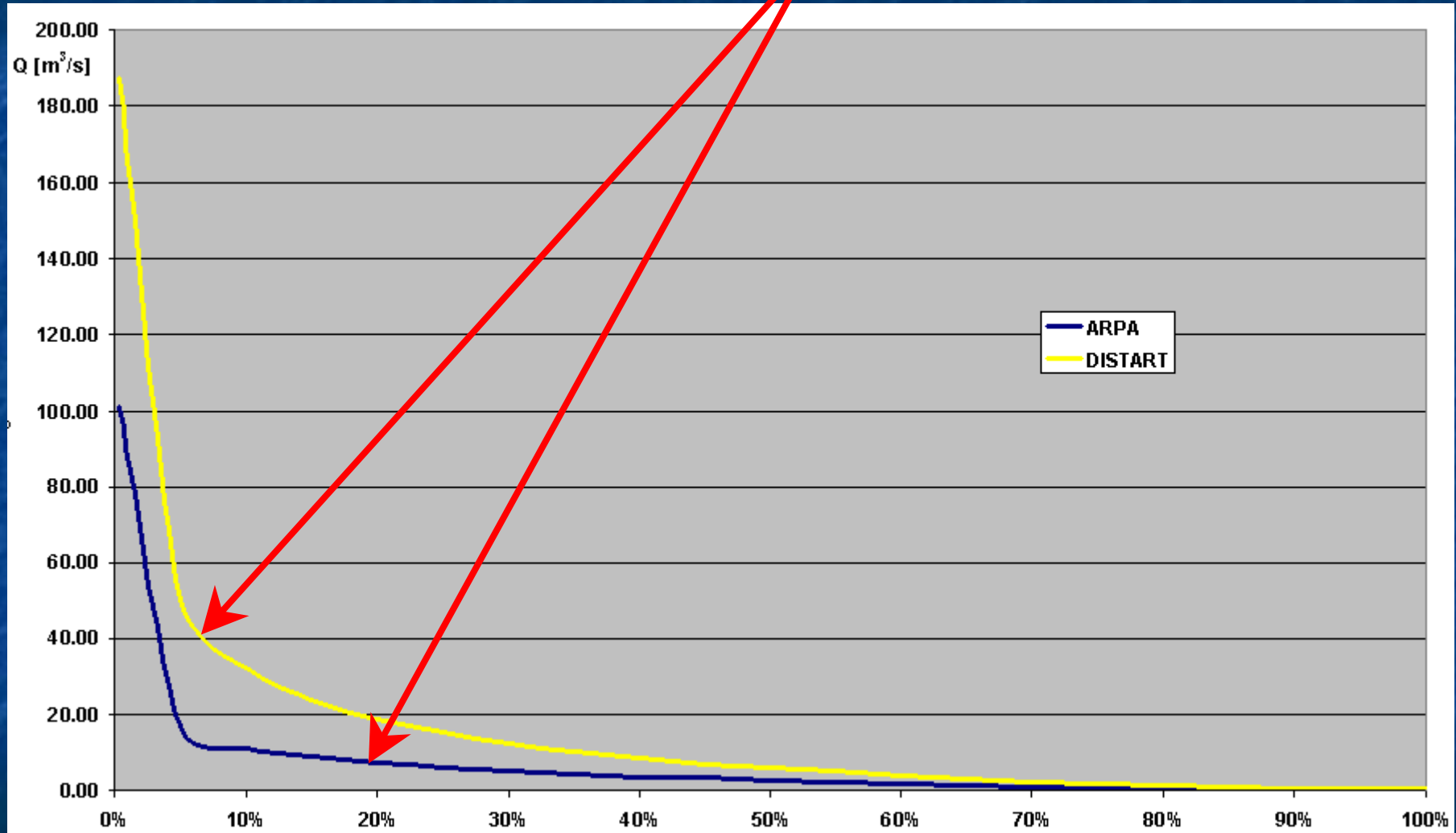
- 600 km² wide
- Elevations ranging from approximately 1400 m asl to 0 m asl.
- Precipitation ranges from 700 to 1100 mm/y on average, (from the coast to the Apennines divide.)



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General catchment characteristics

Flow duration curve assessments

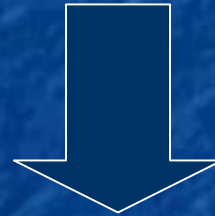


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Main channel characteristics

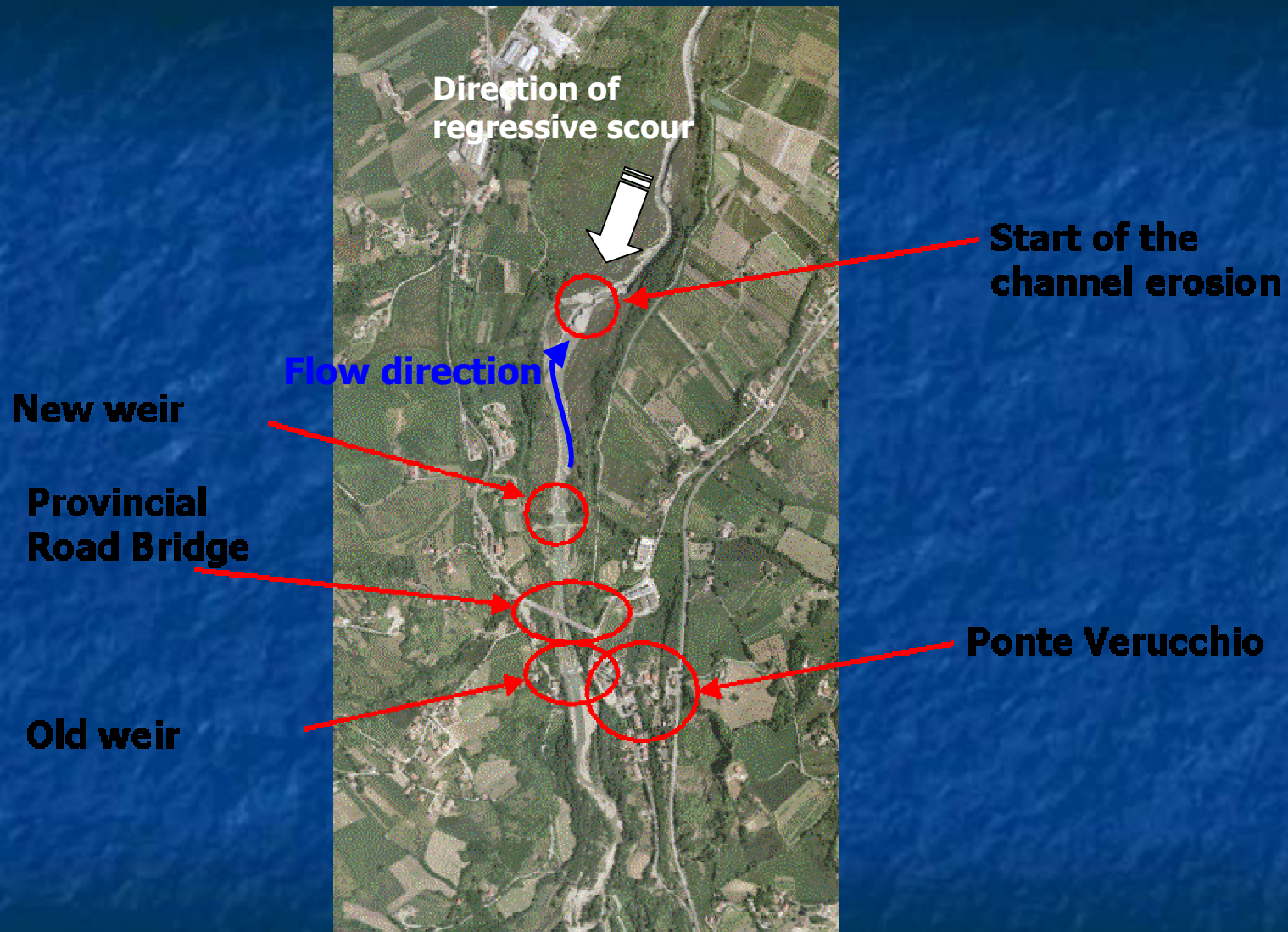
wide gravel bed where braided sub-channels form and evolve continuously

gravel has been extracted in large quantities (stopped in 1980)



- **Channel erosion (Canyon)**
- **hydrogeological risks due to the presence of infrastructures**
- **reduced the solid discharges to the coast**

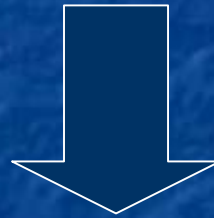
Area of interest



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Position of the problem

**Drop of approximately 15 m
in the plain(natural channel slope is already of the order of
0.1 – 1 %.)**

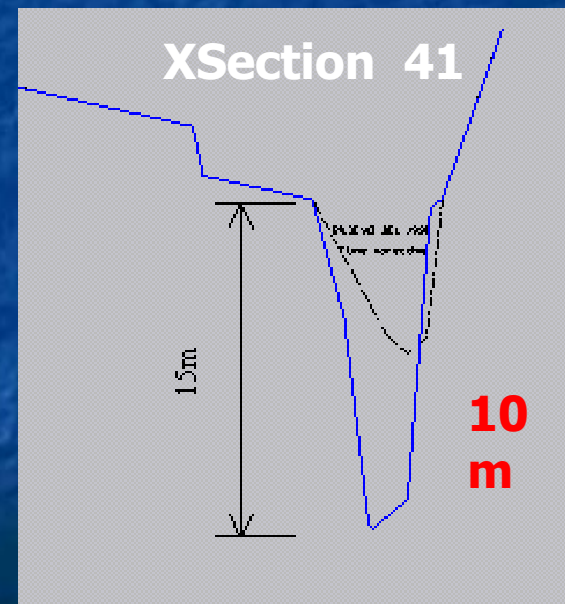
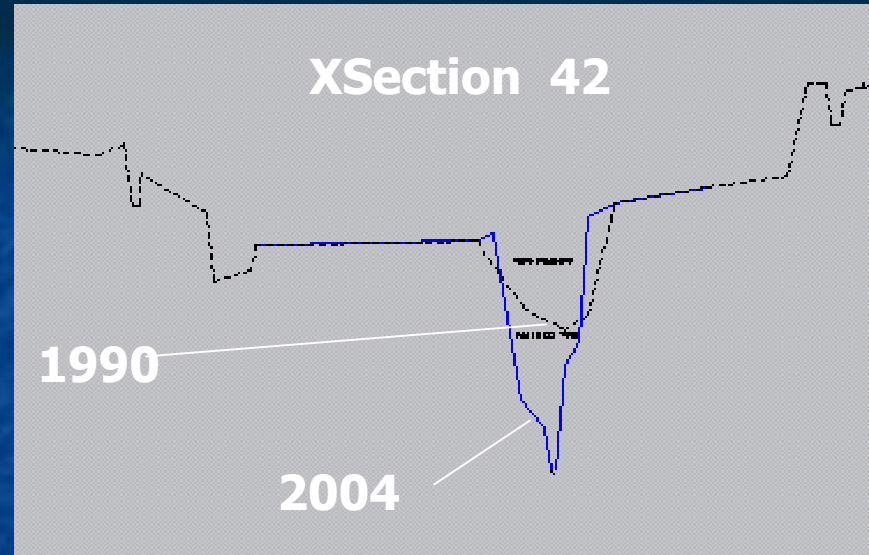


**regressive scour
Rapidly evolved in the last 15 years
1990-2004**



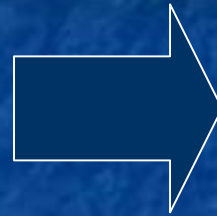
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Position of the problem



Water diversion as a tool for channel stabilization

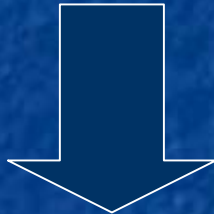
diverting a significant part of the flows



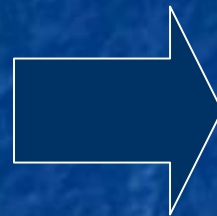
reducing transport capacity of the stream

AND

the scouring pace over extended time periods



HYDROPOWER PRODUCTION



maximise effects of transport capacity reduction

AND

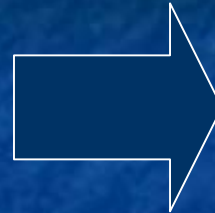
good profitability of energy production



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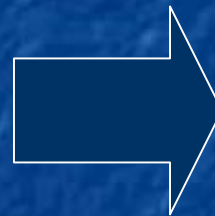
Hydraulic –Transport modeling

natural flow duration curve



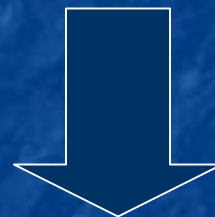
modifications according to different withdrawal hypotheses

hydraulic – transport model of the river



quasi-2D hydraulic model (HEC-RAS)

wide combination of approaches for the estimation of sediment transport capacity

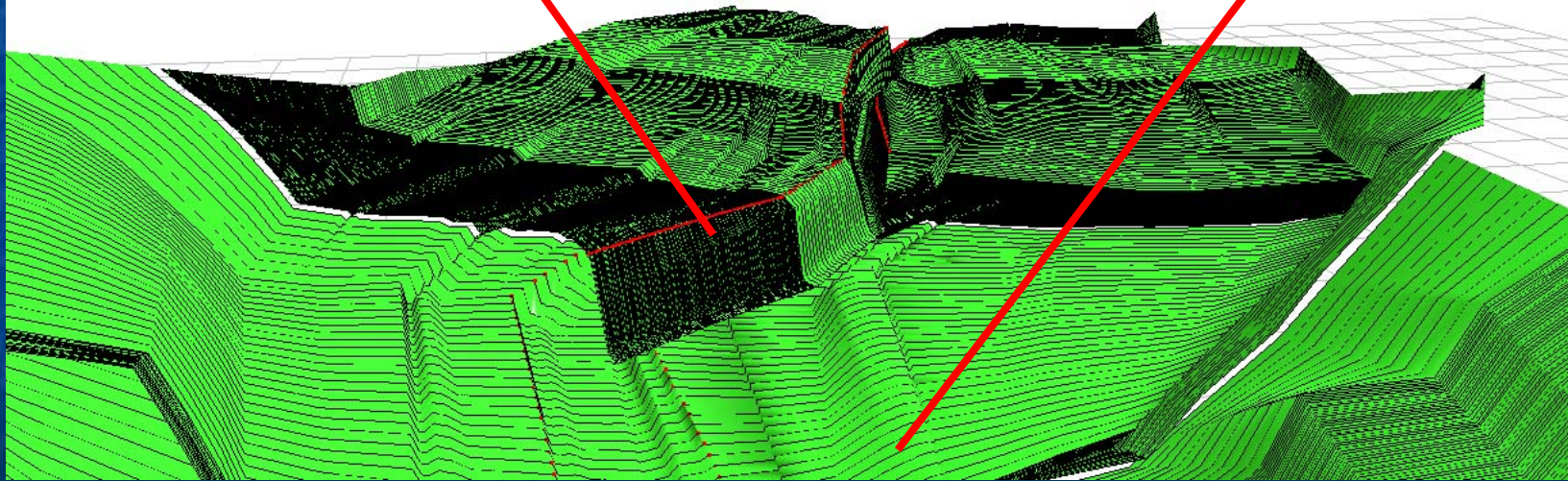
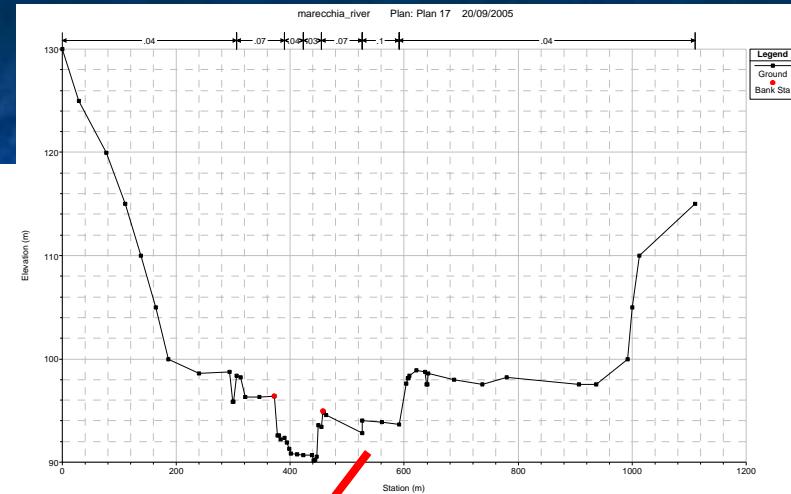
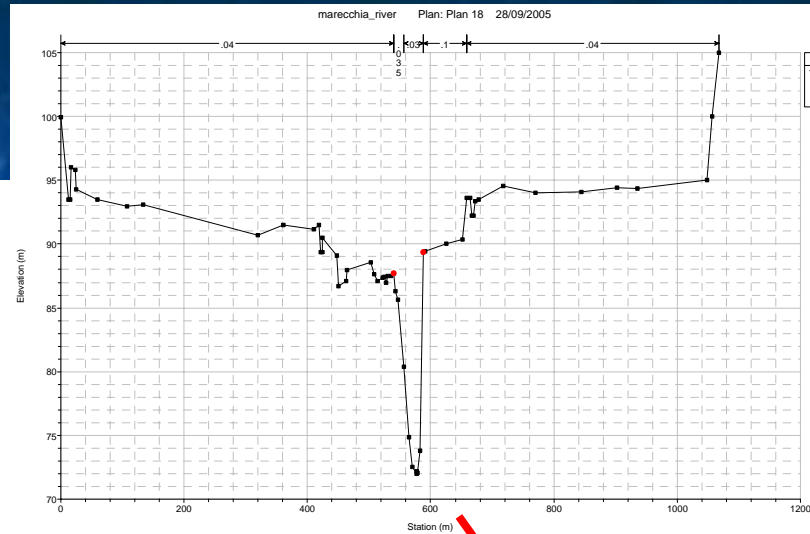


optimal withdrawal potentiality of approximately 8 m³/s



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Hydraulic – Transport modeling



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Hydraulic – Transport modeling

Transport in suspension

Meyer-Peter e Mueller (1948)

Ashida e Michiue (1972)

Engelund e Fredsoe (1976, 1982)

Van Rijn (1984)

Parker (1991)

Transport at the channel bottom

Smith e McLean (1977)

Van Rijn (1984)

Garcia e Parker (1991)

• **D50 = 0.1 mm**
mean representative diameter

• **Different withdrawals hypothesis**

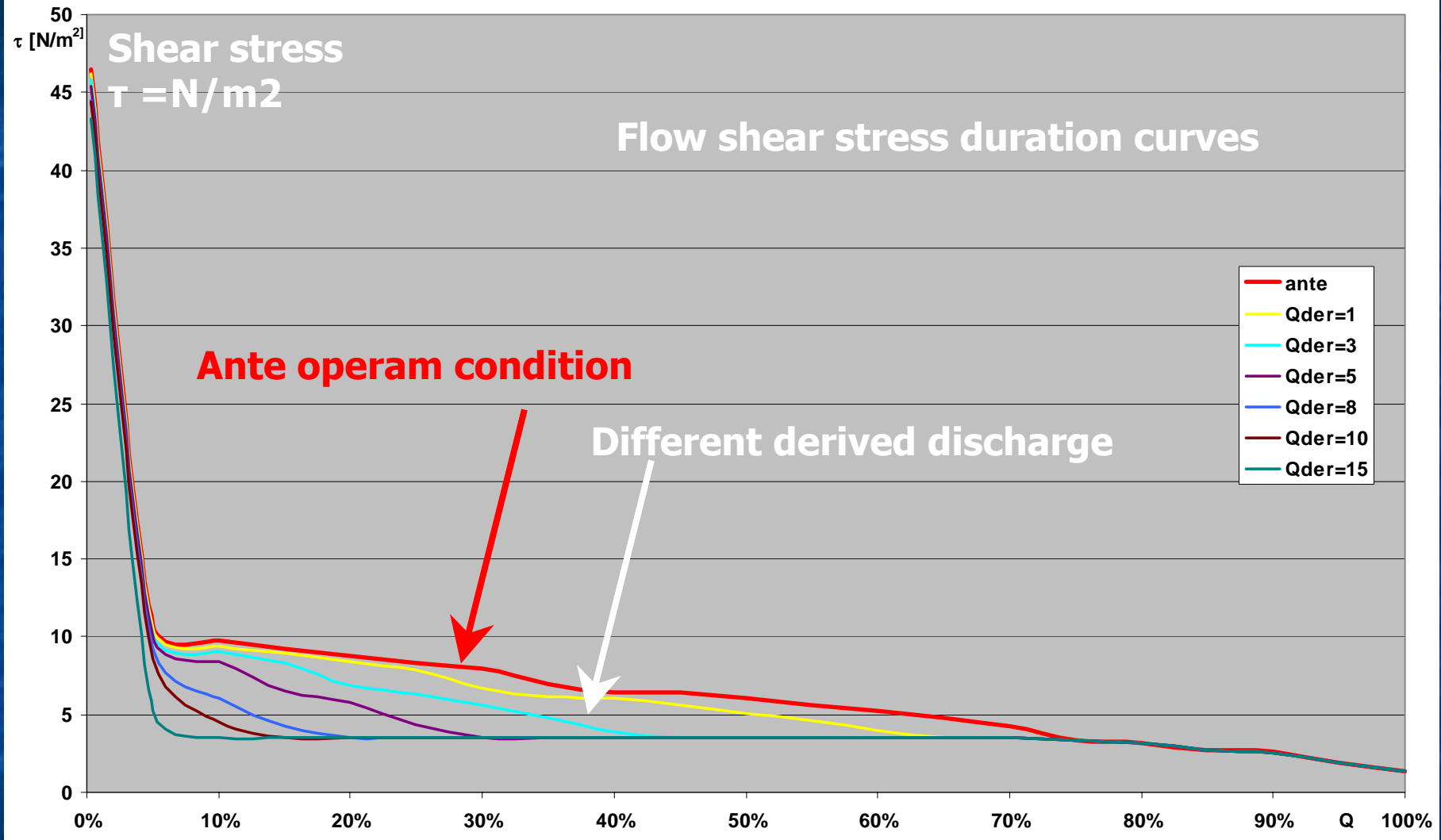


Flow shear stress duration curves –Transport capacity



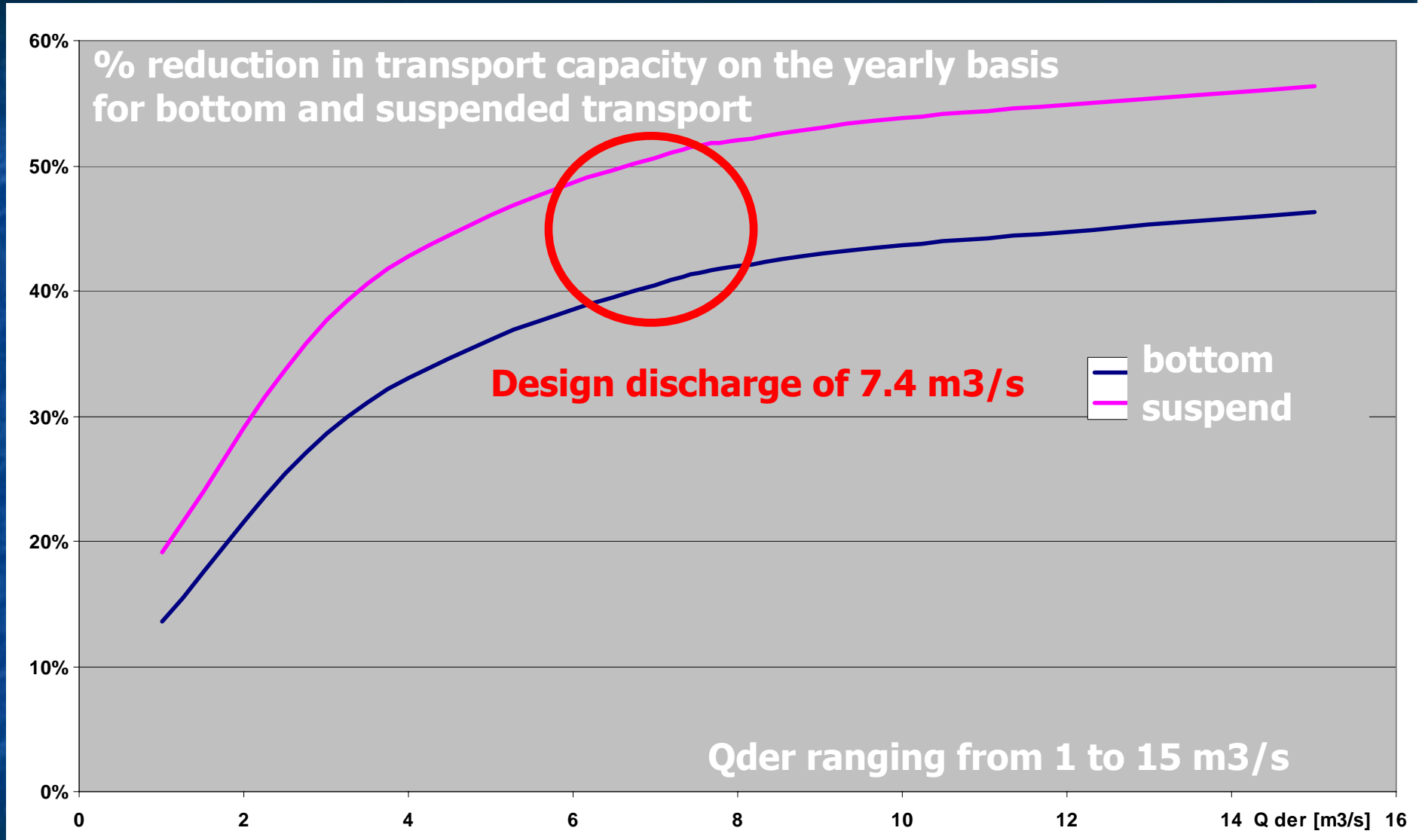
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Hydraulic – Transport modeling



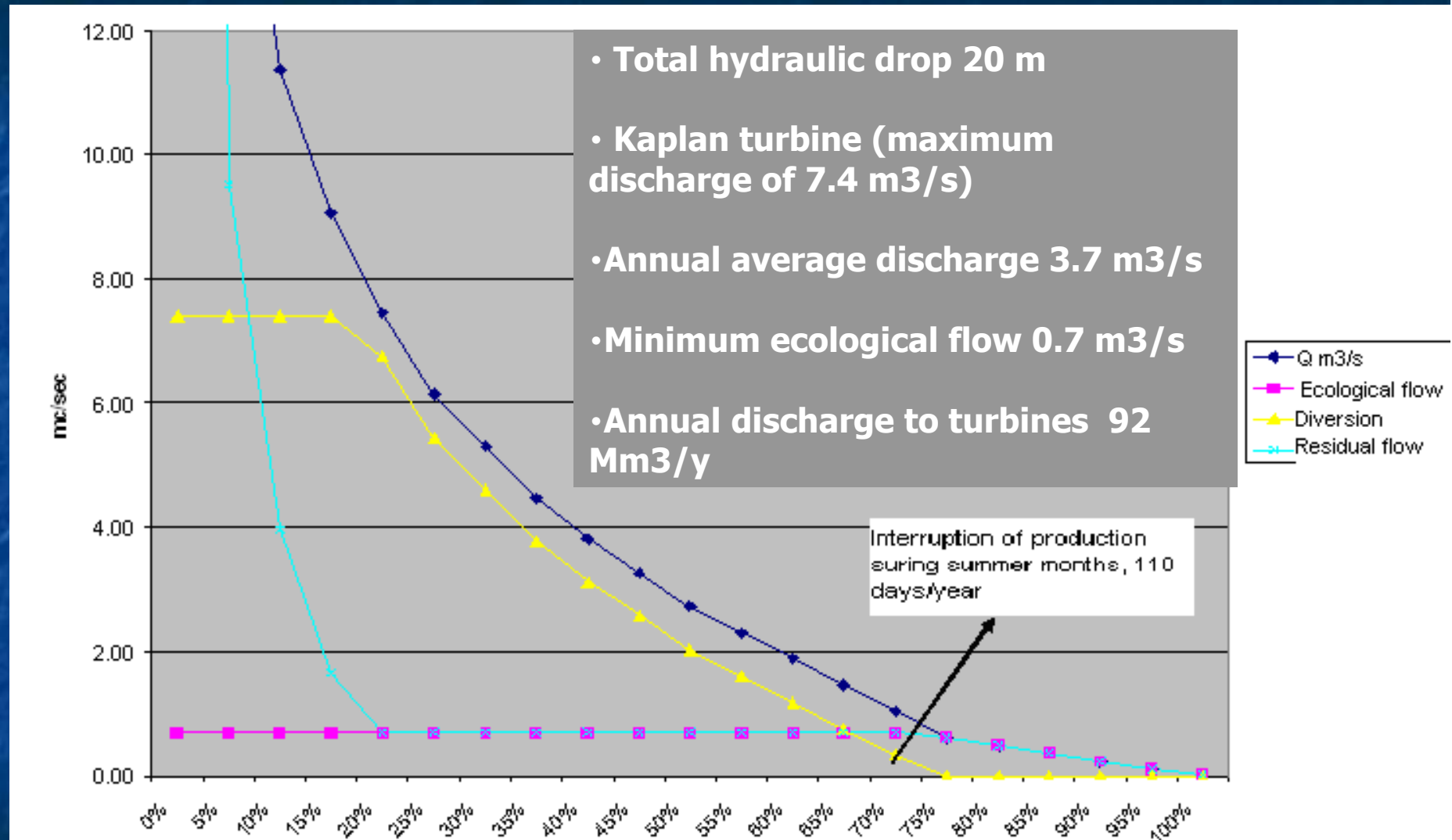
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Hydraulic – Transport modeling



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Evaluation of Hydropower development feasibility



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Evaluation of Hydropower development feasibility

- **Mean annual energy production 3369 MWh**
- **CO2 equivalents 1955 t/y**
- **Investment Pay back period under 3 years**
- **Internal rate of return (IRR) = 39.6 %**
- **Net Present Value (NPV) over 30 yrs of about 1,700,000 Eur
(public incentive to small hydropower plants)**



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Evaluation of Hydropower development feasibility

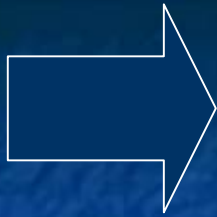
Discharge withdrawal and Riverine habitat modification ???

- Withdrawal affects only a short stretch of the river, approximately 1000 m
- The stretch under consideration is already virtually impermeable to fish migration

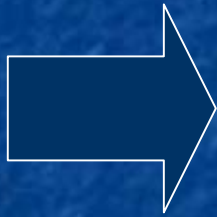


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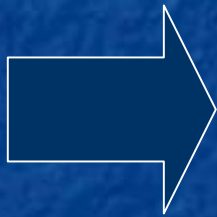
Conclusions



Carefully designed small hydropower plant can be thought of as a multi-objective tool for river management



water withdrawal as a means of scour control



profitability of the plant allows to envisage hydropower development as a strategy to generate funding for river restoration besides



coupling the hydrologic, hydraulic and ecologic understanding of rivers with clean energy production may enhance our capabilities to detect situations where hydropower development is not only sustainable, but also helps a general management of river systems.

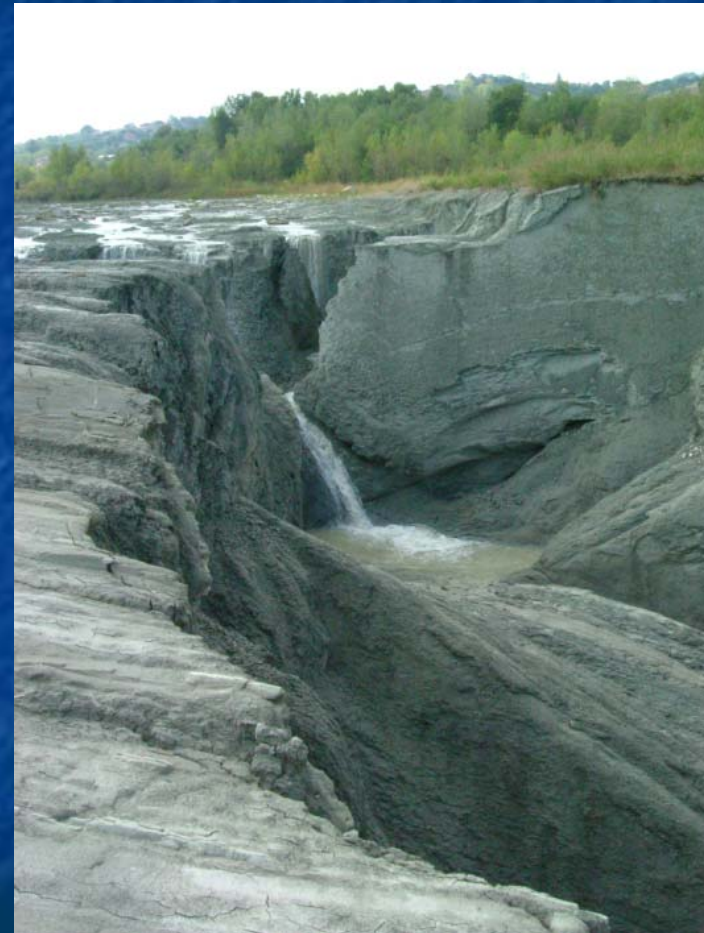


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