

# Hochwasserschutz und Umfahrung von Innichen - kombinierte Nutzung einer öffentlichen Infrastruktur

## Protezione dalle inondazioni e bypass di San Candido - uso combinato di un'infrastruttura pubblica

# Inhalt

- Chronik
- Eine Idee wird geboren
- Geologische Rahmenbedingungen
- Hydrologie und Hydraulik
- Fazit



Innichen

Vierschach

Kleine Drau

Drau

Sextnerbach

Stausee

- 12.05.1493 Heftige Gewitter führen zum Hochwasser in der Drau. Innichen Überschwemmt.
- Aus der Chronik des Franziskanerklosters 1707, 1719, 1741, 1747, 1757, 1768, 1772 08.10.1823
- Überschwemmungen durch die Drau. Der Sextnerbach bricht in Innichen aus und verursacht Zerstörungen. Überschwemmungen in Vierschach und Winnebach.
- 16.06.1879 Ausbruch der Drau in Innichen





**1889 Überschwemmung von Innichen**

## Die Überschwemmungskatastrophe vom 2. – 5. September 1965 (aus der Chronik der Familie Franz Brugger)

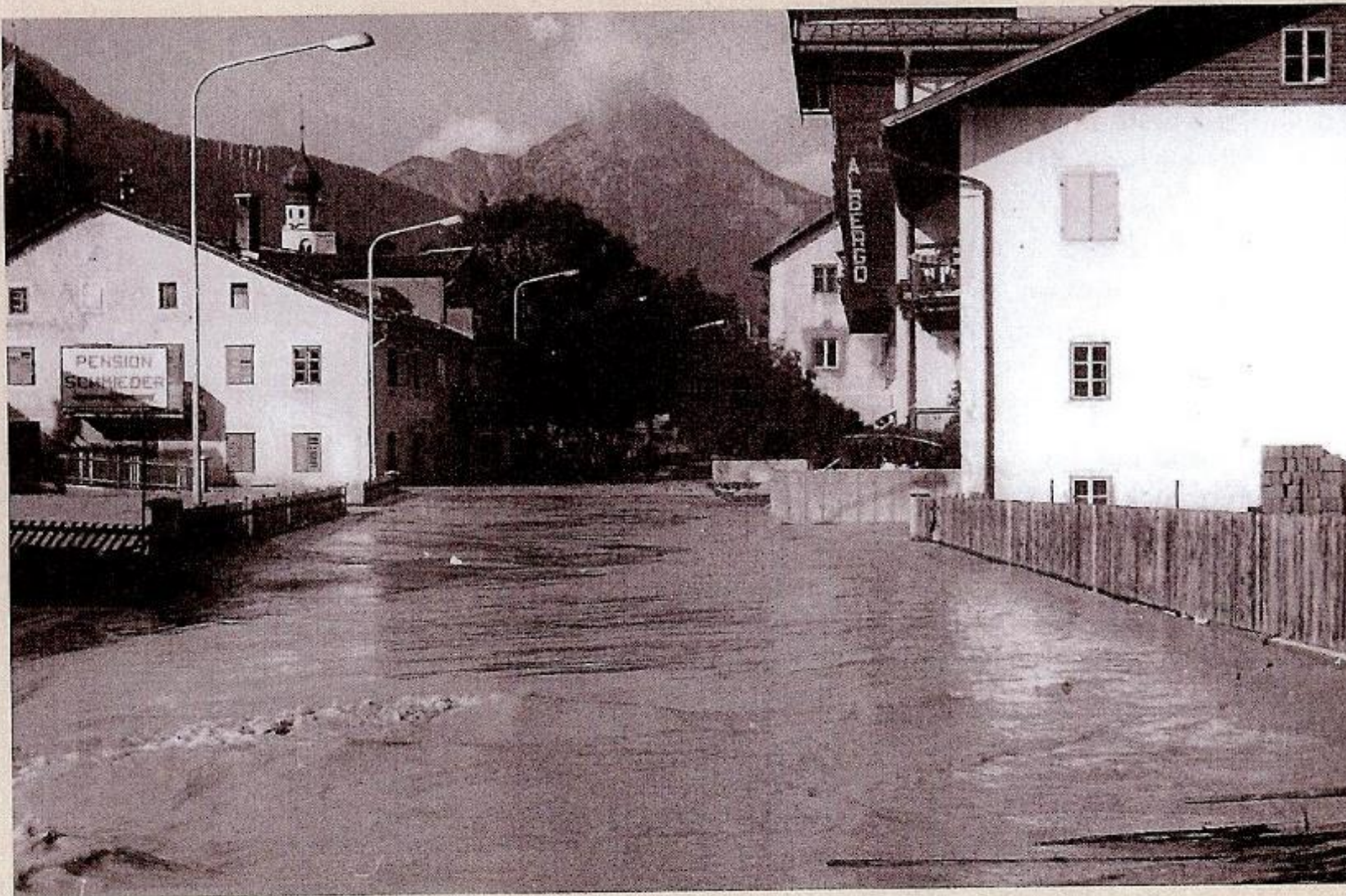
- regnerisches Frühjahr und nasser Sommer
- Dauerregen vom 31.08 bis zum 03.09
- Schäden im gesamten Pustertal (Mühlbach bis Lienz)
- Wildholz- und Geschieberückstau an der Botenbrücke
- Das 2,0 – 2,5 m tiefe Bachbett völlig aufgefüllt.
- Sextnerbach bricht am 03.09 orogr. rechts aus und fließt durchs Dorf.
- 12 Gebäuden standen unter Wasser, beim Hotel Eden stand das Wasser 1,20 m hoch.
- Auch die Franziskanerkirche einige cm. unter Wasser
- Durch Positionierung von Raubbäumen und mit Hilfe eines Baggers gelingt es Dämme zu bilden.



## Die Überschwemmungskatastrophe im Jahre 1966 (aus „Im Kampf gegen Feuer und Wasser“, Festschrift FF)

- 16. - 19. August Feuerwehr im Einsatz
- Ende Oktober ergiebige Schneefälle auf den Bergen, dann setzt Föhnwetter ein, dem eine Regenperiode folgt.
- Am 04. November tritt der Bach (Weidach- und Raffelebrücke) wieder über die Ufer
- Häuser im Waidach, Kirche und Kloster der Franziskaner, Centralcafé, die Geschäfte Mühlmann und Müller-Rainer, die Kellerräume des Hotels Miramonti, die Gerberei Mitterhofer wurden überschwemmt.

Durch die  
Tagger-  
Wagenhütte  
wurde das  
Wasser  
nach Westen  
gedrängt,  
es ist  
dann nach  
Osten  
abgeflossen







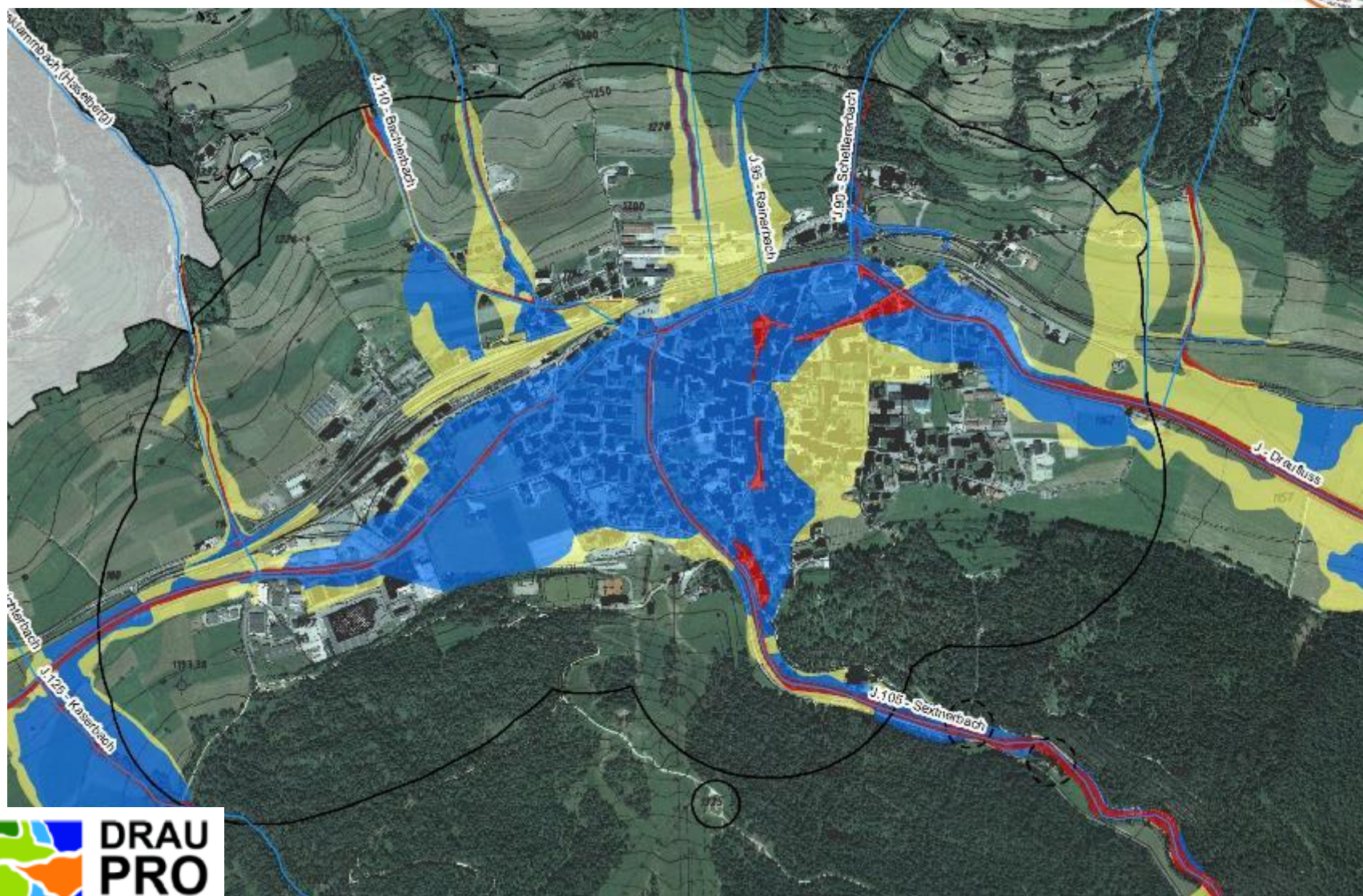
Specialisti Altoatesini per San  
Candido  
Südtiroler Fachgruppe für Innichen



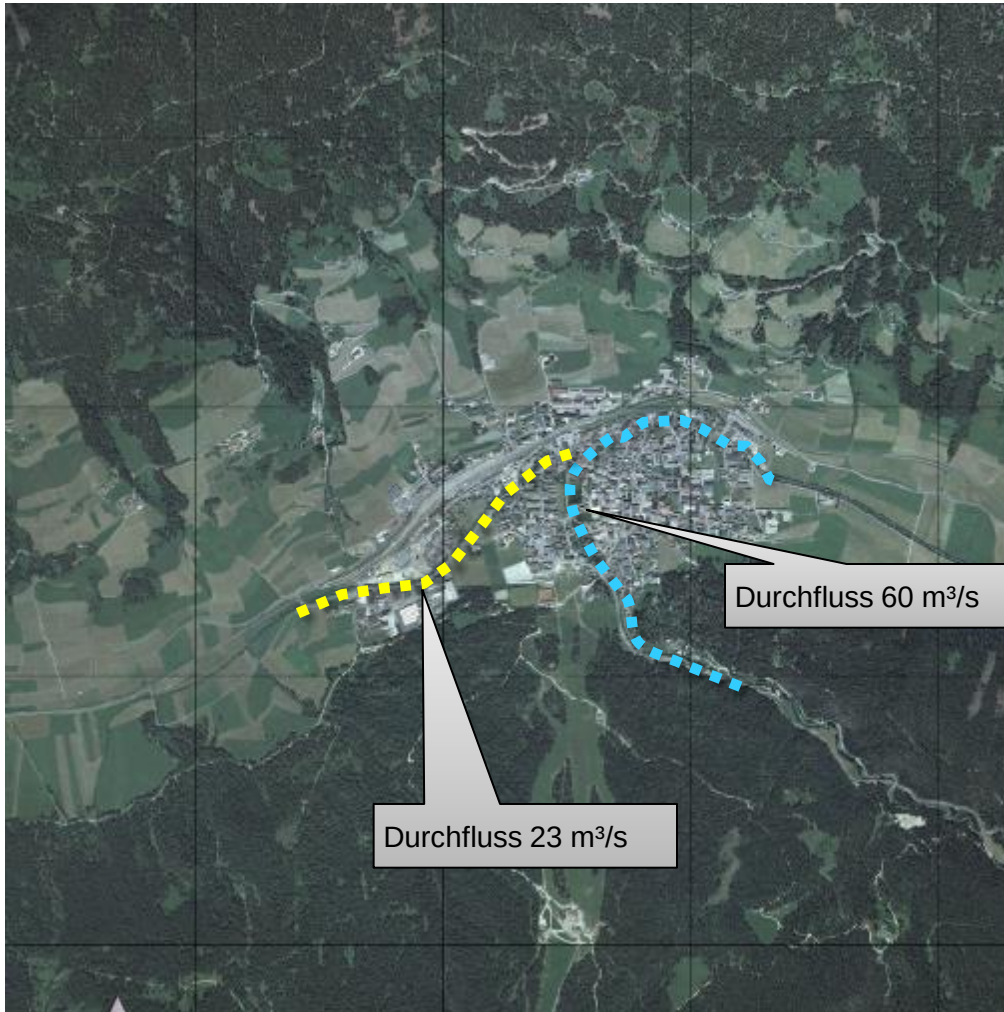
# „VAIA“ (2018)











- Rückhaltebecken
- Absenkung des Flussbettes
- Reinigung Drau +

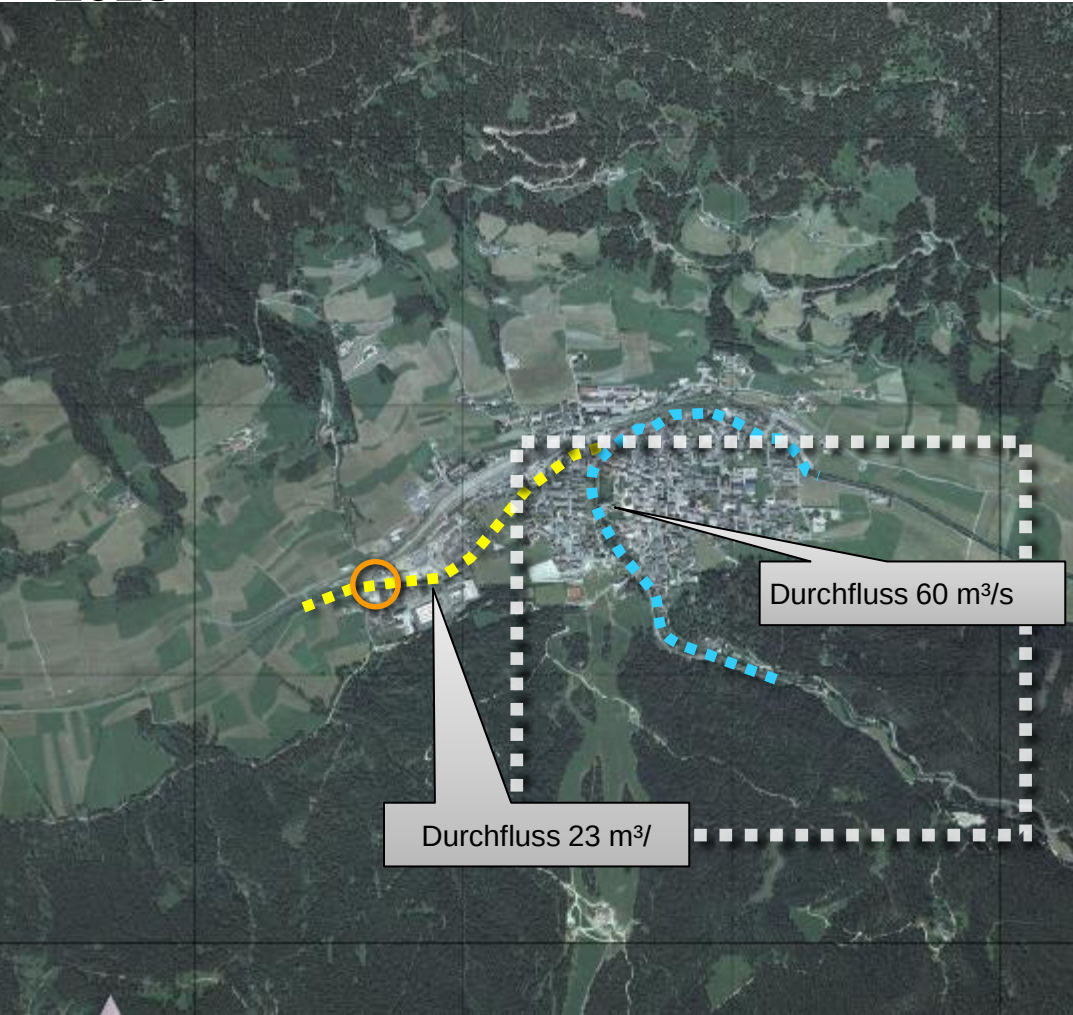


### Querschnittsanpassung

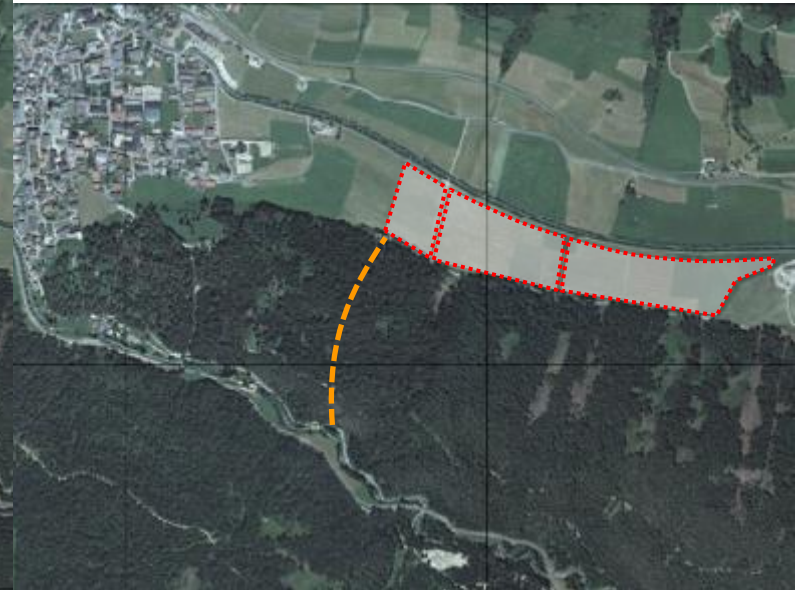




2013



- Absenkung des Flussbettes
- Reinigung Drau + Querschnittsanpassung
- Bypass





# Eine Idee wird geboren

| TR<br>(Jahren) | Q <sub>max</sub><br>(m³/s) |
|----------------|----------------------------|
| 30             | 83                         |
| 100            | 110                        |
| 300            | 136                        |

| TR<br>(Jahren) | Q <sub>max</sub><br>(m³/s) |
|----------------|----------------------------|
| 30             | 50                         |
| 100            | 50                         |
| 300            | 50                         |

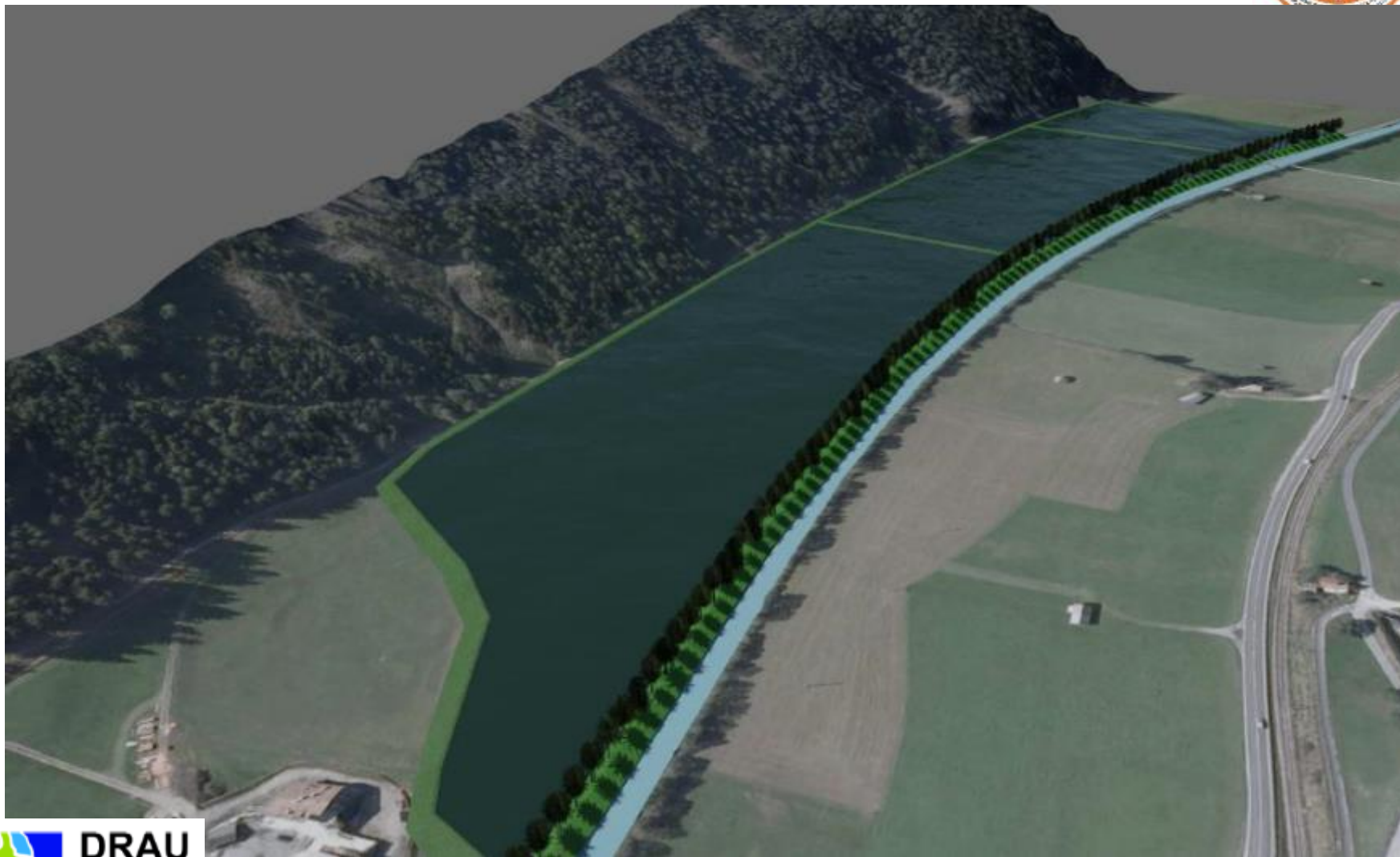
| TR<br>(Jahren) | Fläche<br>(m²) |
|----------------|----------------|
| 30             | 25.000         |
| 100            | 55.000         |
| 300            | 100.000        |
| GESAMT         | 180.000        |

| TR<br>(Jahren) | Q <sub>max</sub><br>(m³/s) |
|----------------|----------------------------|
| 30             | 83 - 50 = 33               |
| 100            | 110 - 50 = 60              |
| 300            | 136 - 50 = 86              |

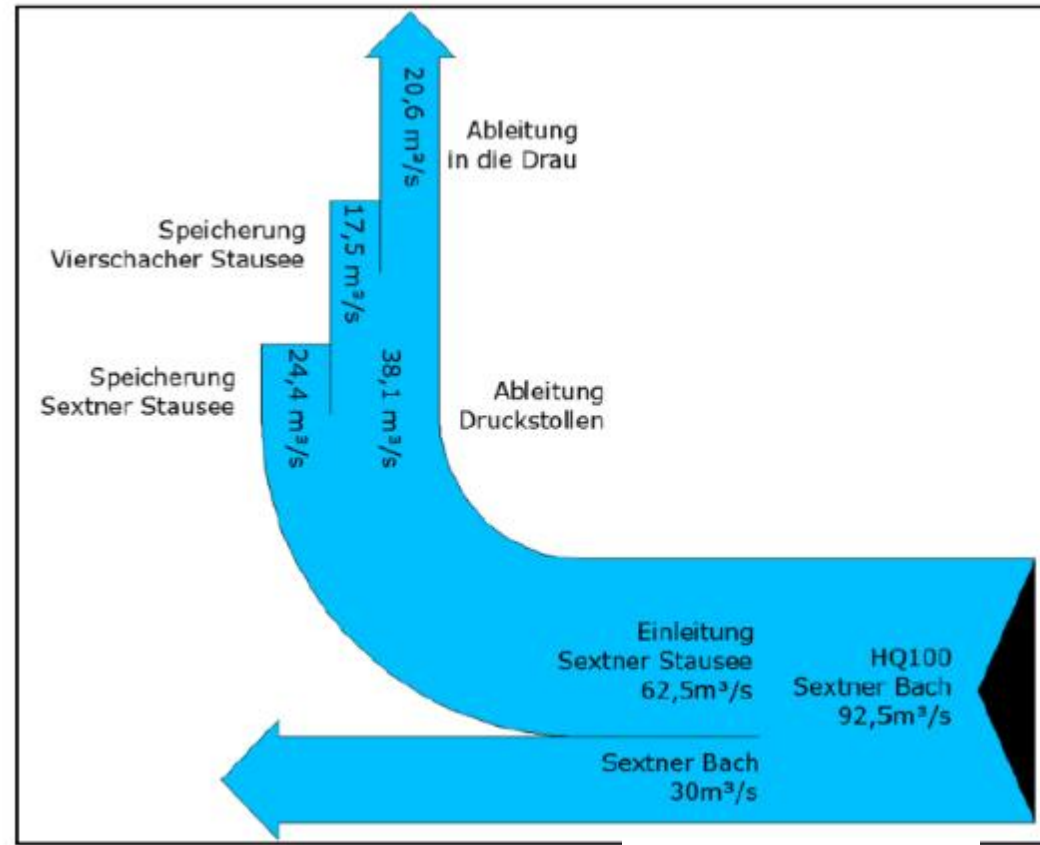
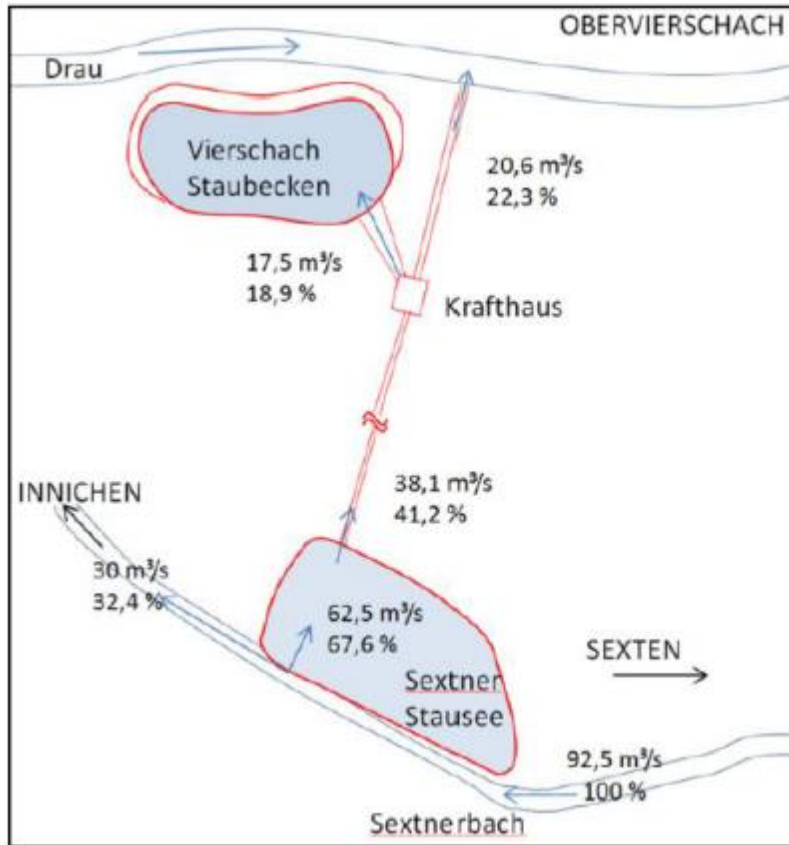
Aktivierung Bypass

Hochwasserereignis

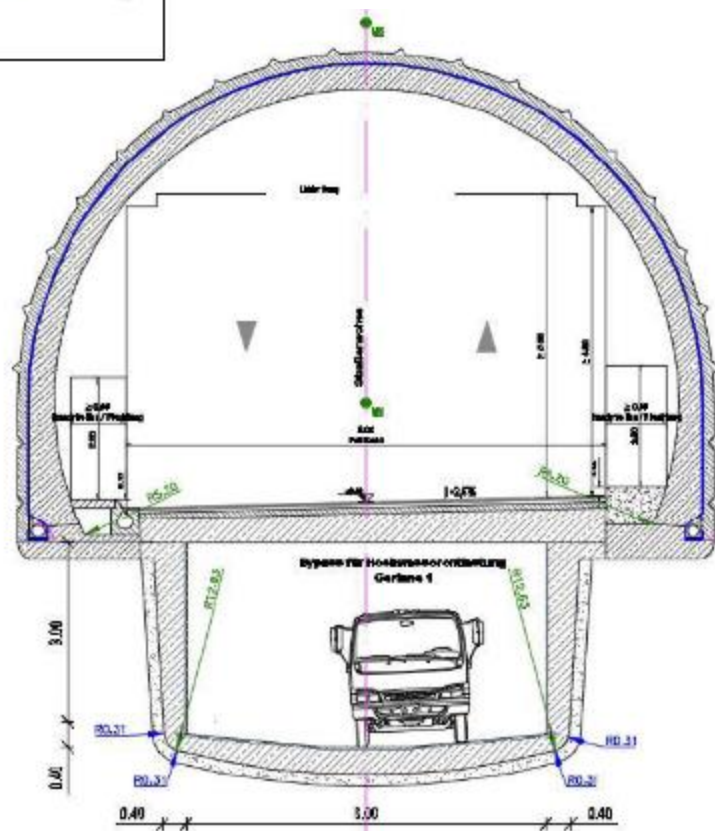
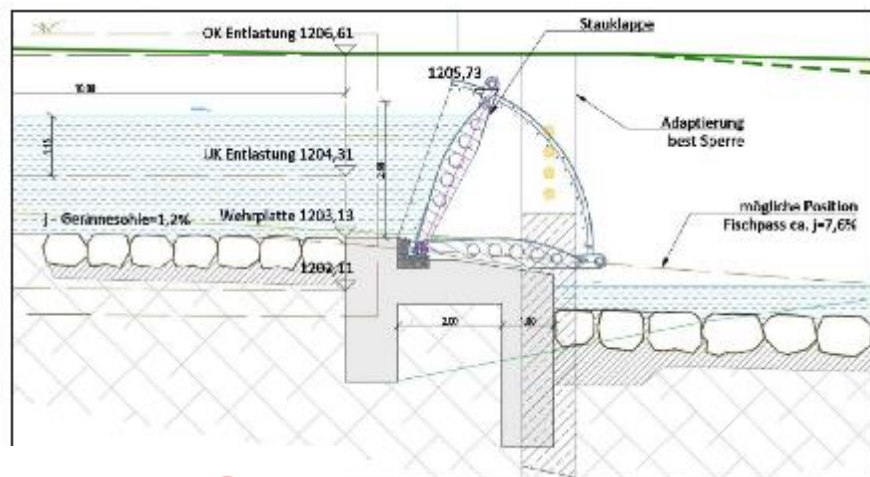
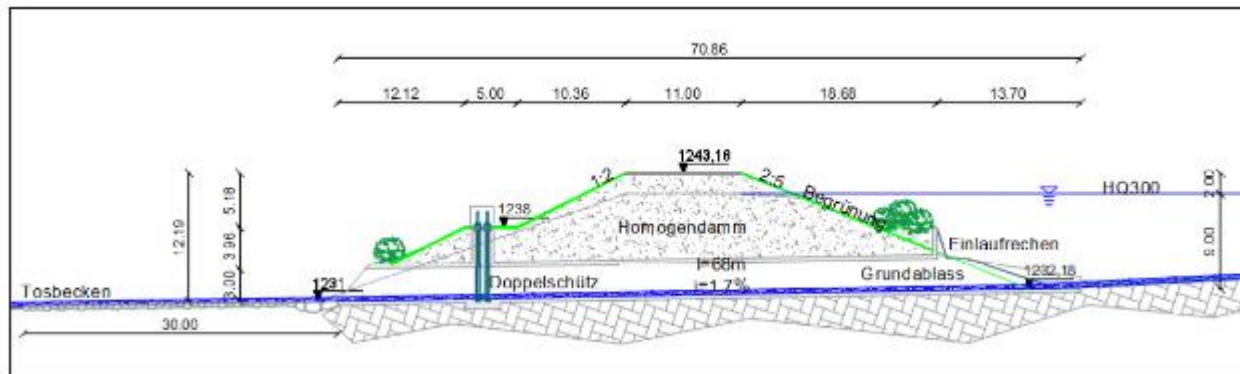




2017







**2020**

## **Specialisti Altoatesini per San Candido Südtiroler Fachgruppe für Innichen**

### **Drei Vorschläge:**

- **Variante A** - Entlastungsstollen
- **Variante B** – kurzer Straßentunnel = Entlastungsstollen
- **Variante C** - langer Straßentunnel + Entlastungsstollen + Talsperre

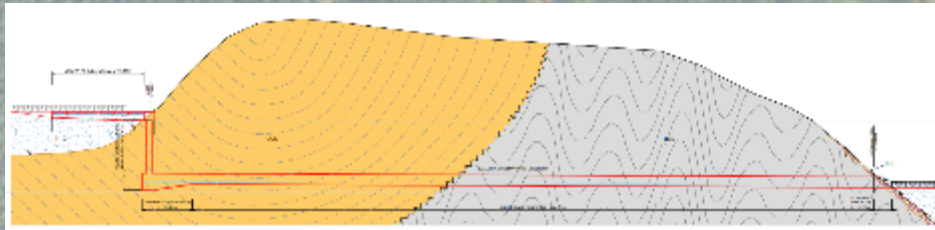


# Variante A

HQ durch Innichen bis 40 m<sup>3</sup>/s

Rückgabekanal

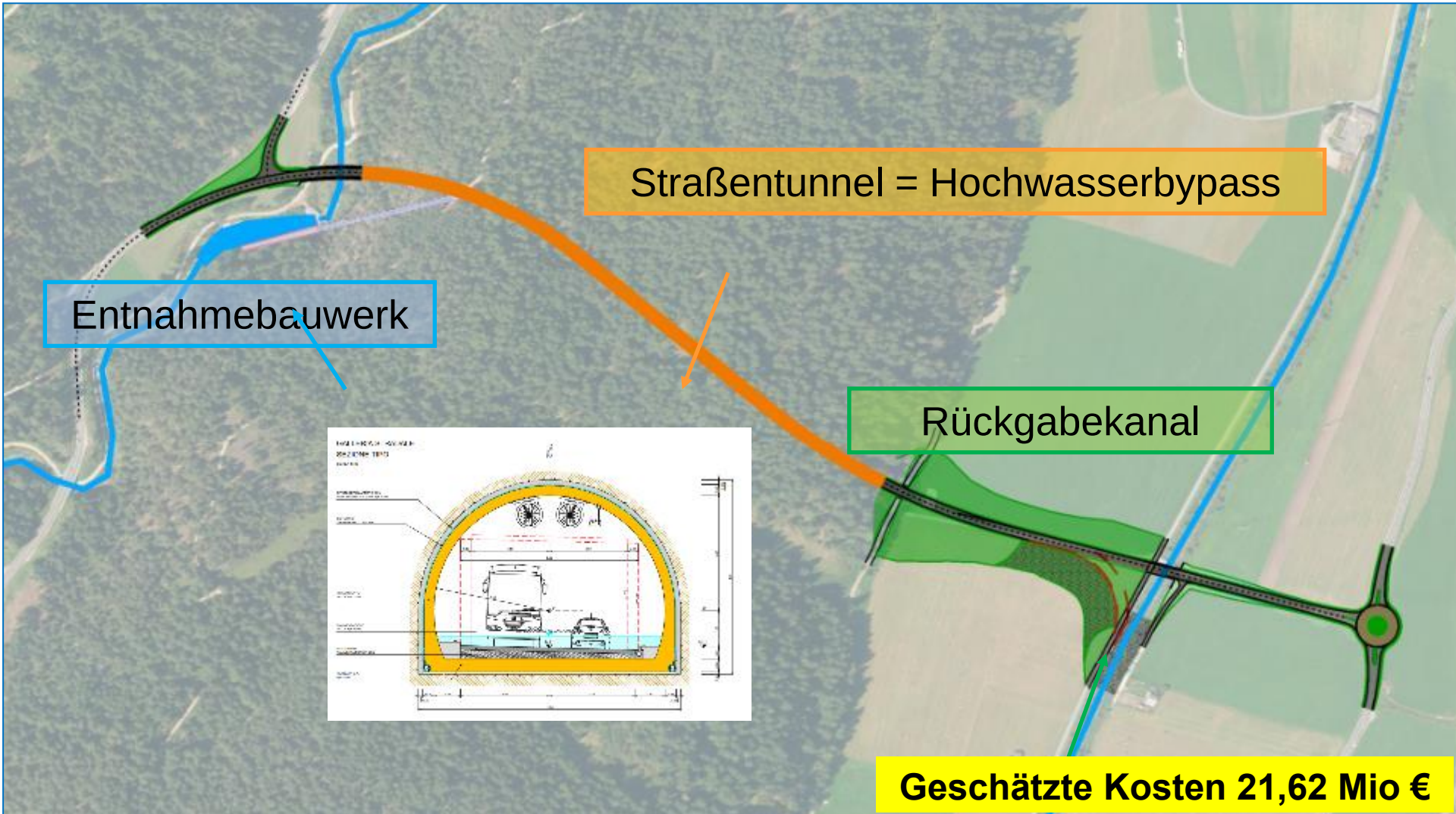
Entlastungsstollen



Entnahmebauwerk

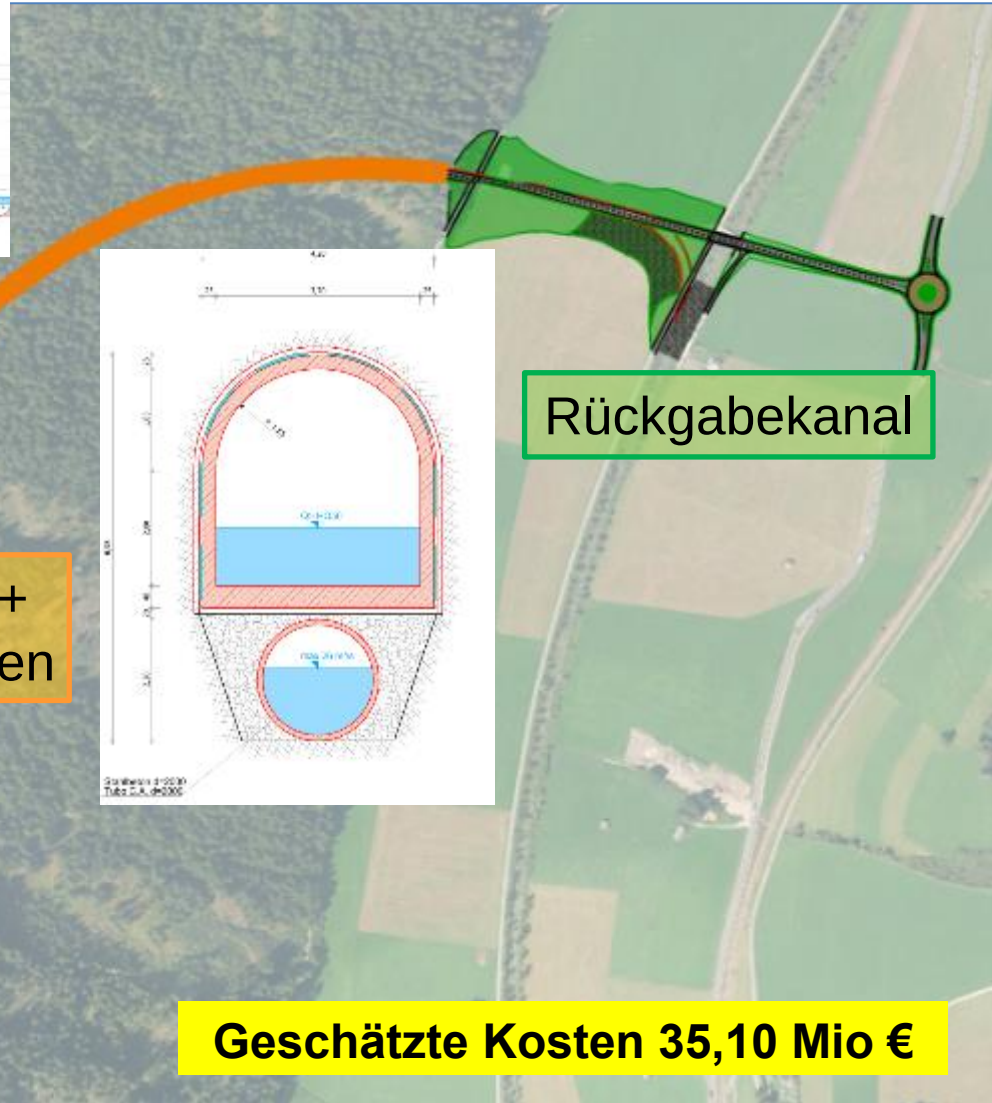
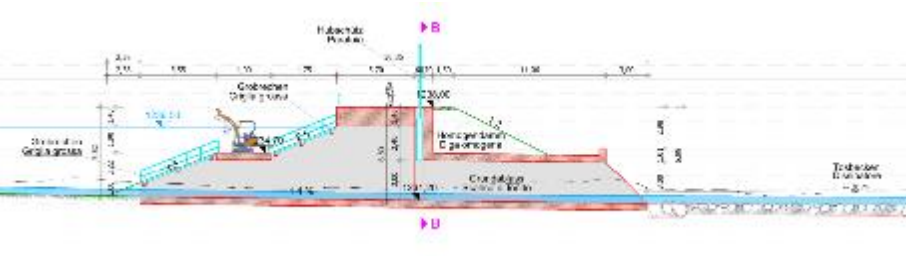
**Geschätzte Kosten 10,95 Mio €**

# Variante B





# Variante C

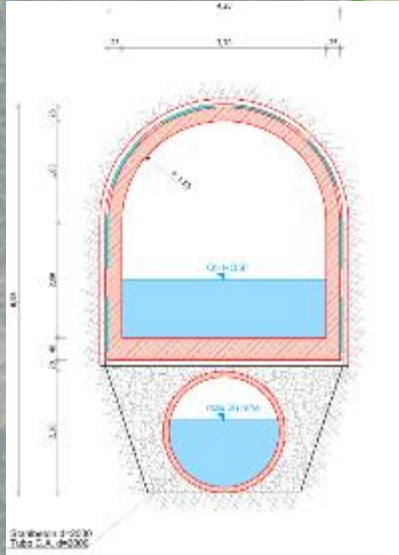


Talsperre

Straßentunnel +  
Entlastungsstollen

Entnahmebauwerk

Rückgabekanal



**Geschätzte Kosten 35,10 Mio €**

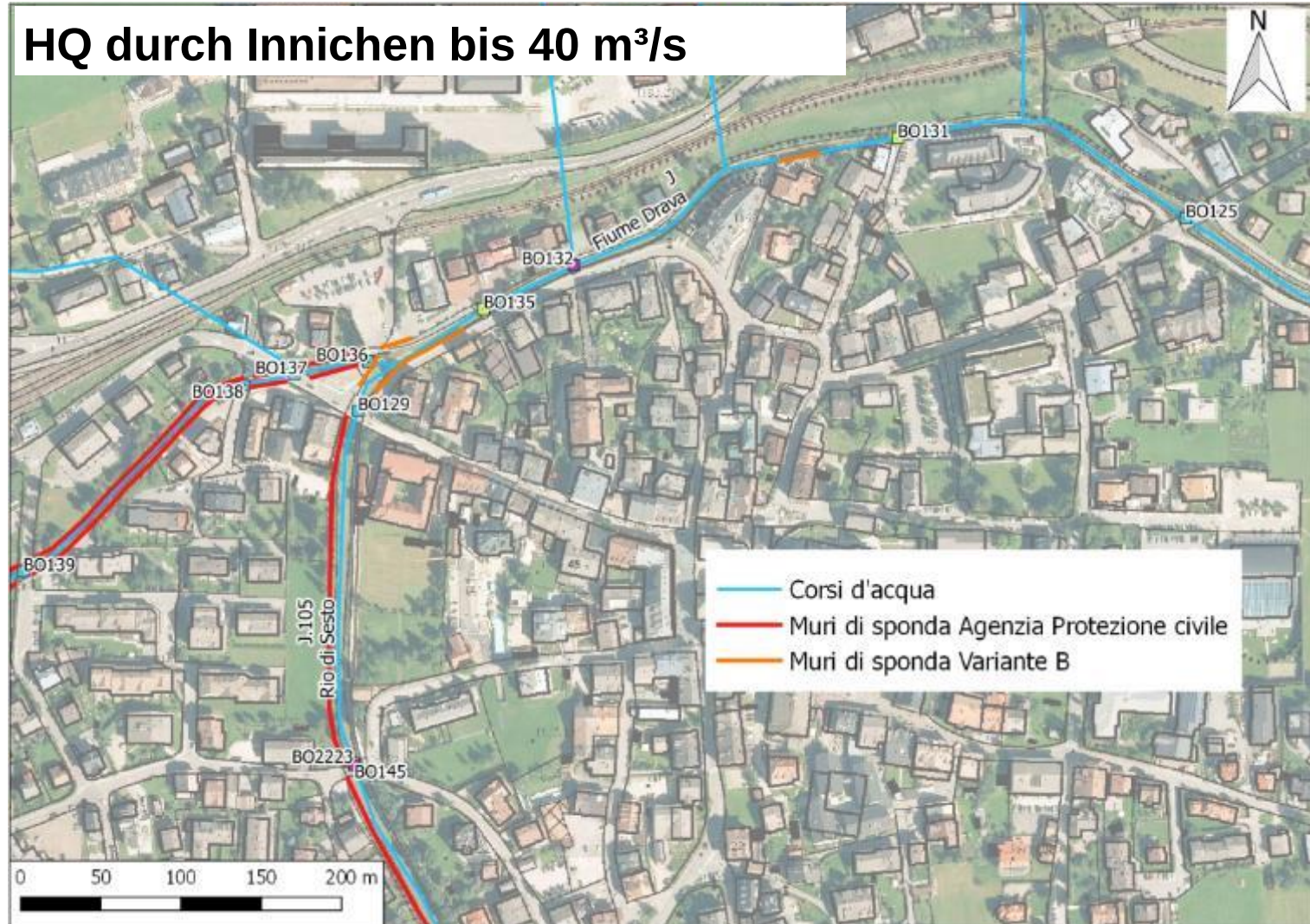




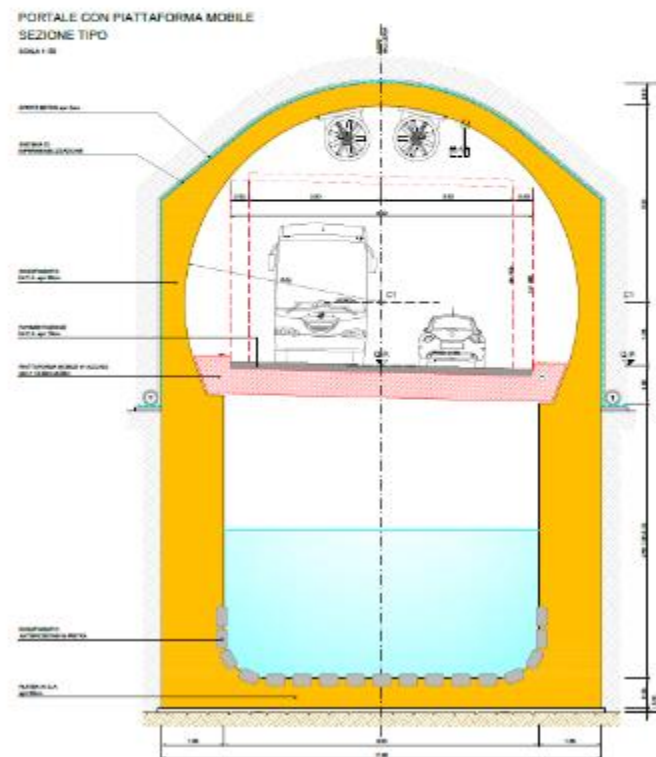
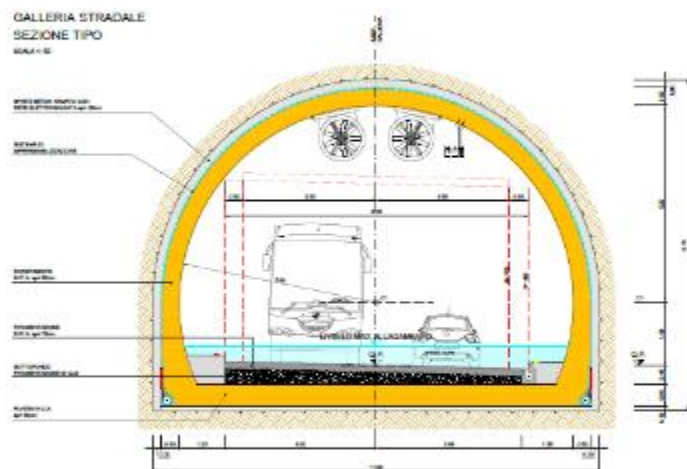
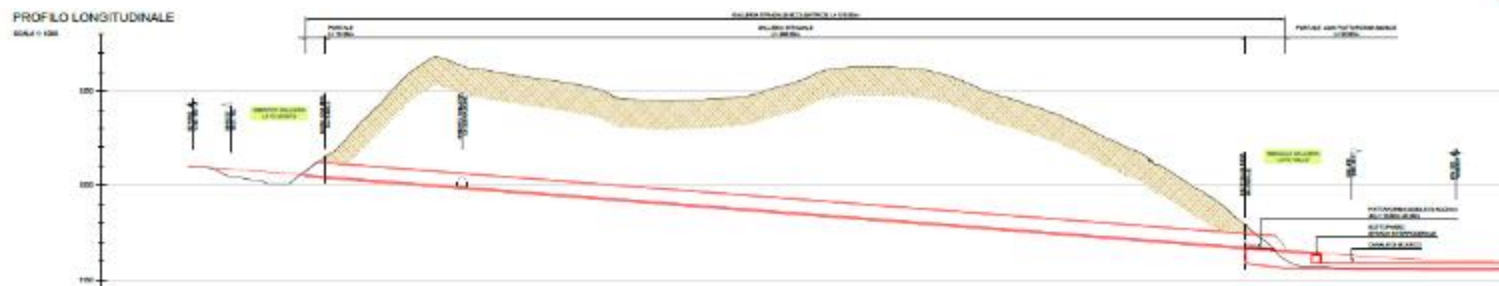


# Variante B

HQ durch Innichen bis 40 m<sup>3</sup>/s

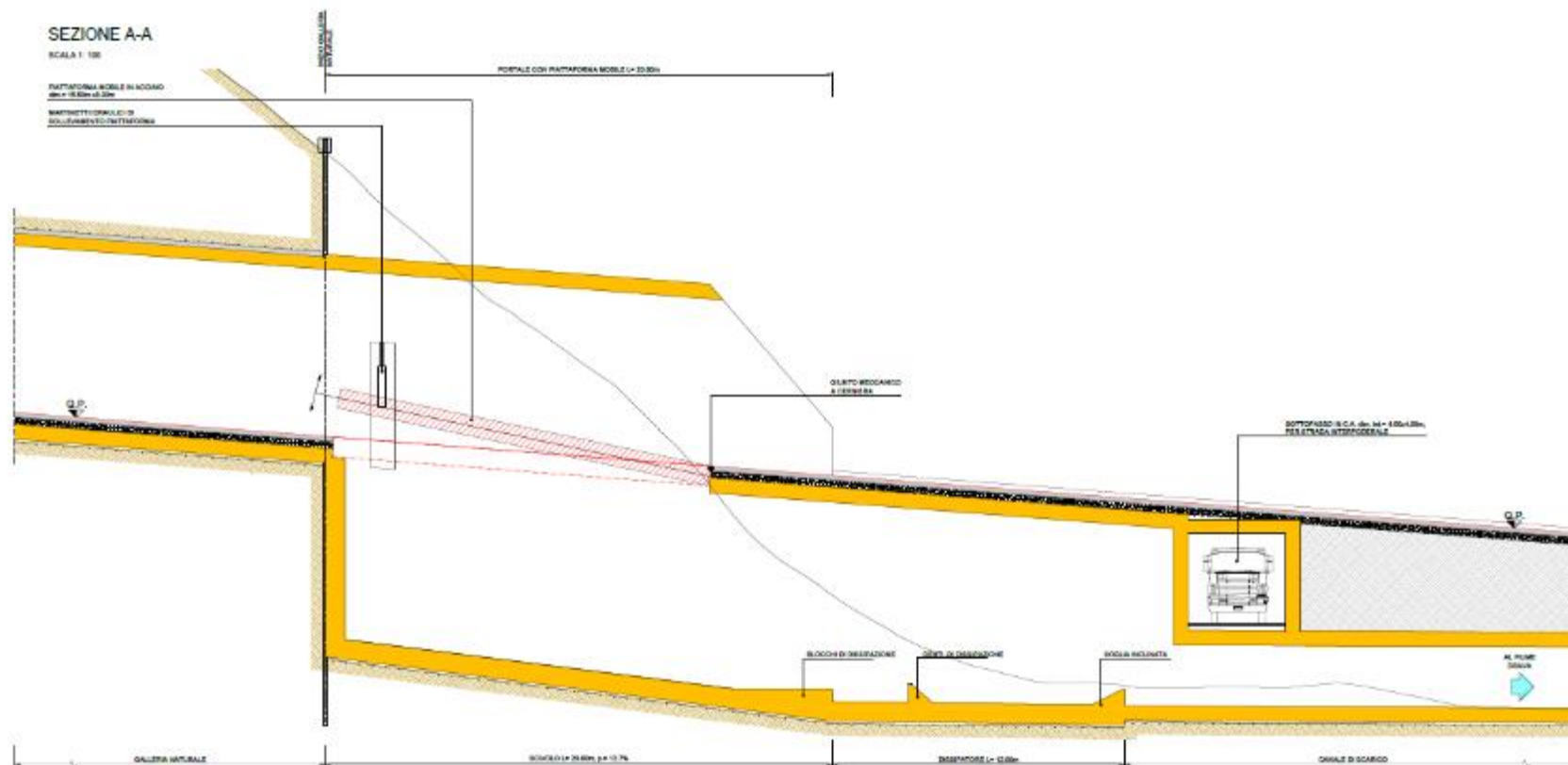


# Variante B

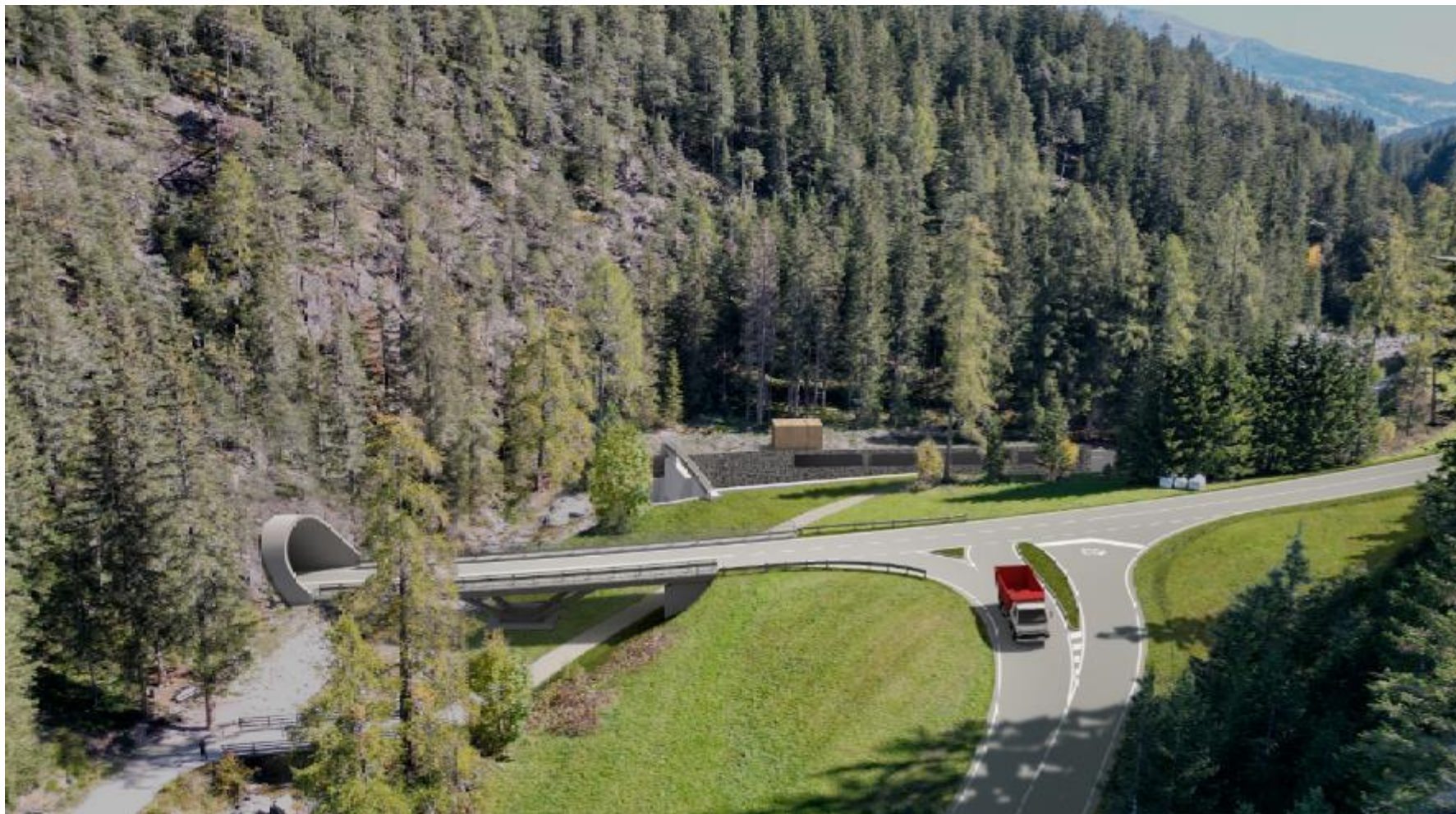




# Variante B



# Variante B



Specialisti Altoatesini per San  
Candido  
Südtiroler Fachgruppe für Innichen



# Variante B



Specialisti Altoatesini per San  
Candido  
Südtiroler Fachgruppe für Innichen

# Gruppo di Lavoro



Coordinamento, progettazione idraulica, strutture, VIA



Geologia, idrogeologia, rilievi geologici



Geologia, idrogeologia, rilievi geologici



Progettazione idraulica e geotecnica, rilievi topografici



Progettazione gallerie e geotecnica



Progettazione strutturale e impianti



Progettazione stradale e sicurezza



# Geologie

1. Geologischer Überblick
2. Geländeerhebungen
3. Durchgeführte Untersuchungen
4. Ergebnisse der Untersuchungen
5. Erstellung des geologischen Modells

**Geol. Ursula Sulzenbacher**  
**Geol. Simone Tacus**  
**Geol. Alvaro Sequani**  
**Geol. Stefano Marighetti**

**Specialisti Altoatesini per San Candido**  
**Südtiroler Fachgruppe für Innichen**



# Geologischer Überblick



DOBBIACO  
FOGLIO 016  
SÜDTIROL ALTO ADIGE

## LEGENDA

— Variante A — Variante B — Variante C

### DEPOSITI CONTINENTALI QUATERNARI

UNITÀ NON DISTINTE IN BASE AL BACINO DI APPARTENENZA

#### SISTEMA POSTGLACIALE ALPINO

Comprende i depositi postglaciali d'isostasia, lacustri, d'altitudine (grande espansione glaciale).  
Gravie sabbiose-finosse con finoclasti, a stratificazione orizzontale o incrociata, con intercalazioni di livelli o lenti di sabbia (depositi aluvionali). Limiti argillosi, torbo, talora con intercalazioni carbonifere (depositi palustri). Dimensione a supporto di clasti (di origine massiva, massivi o con intercalazioni di ghiaie e sabbie) ma sedimentati (depositi di detriti dove l'età di origine media). Ghiaie e blocchi a tessitura da parzialmente aperta ad aperta, con elementi angolari di provenienza locale (depositi di versante). Dimensione media a supporto di clasti e di matrici ghiaie e blocchi elementari anche di grandi dimensioni (accumuli gravitativi). Limiti sabbiosi massivi con scheletro ghiaioso variabile (depositi coluviali). Ghiaie e sedimenti (in spessi) (depositi antropici). Limiti superiori coincidono con la superficie topografica. Spessore: 1-100 m.  
PLEISTOCENE SUP. p.p., ATTUALE

#### BACINO GLACIALE ADIGE-DRAVE

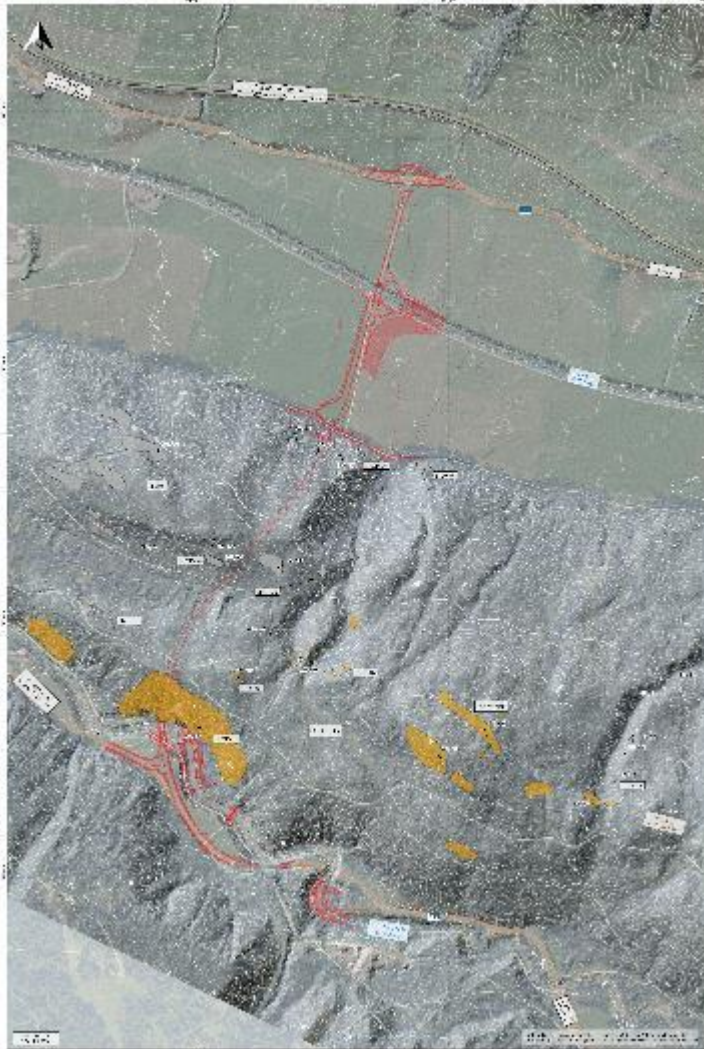
#### SISTEMA DEL GARDA

Comprende le unità collegate con l'ultimo massimo glaciale.  
Dimensione a supporto di matrici (di clasti, da poco addensati ad addensati) (di indifferenziati e stratificati). Dimensione media, a supporto di matrici, con clasti elementari a spigoli smussati, talora striati e a "feno di stiro", da addensati e molto addensati (di sfalsamento). Ghiaie sabbiose stratificate, con livelli di sabbie finissime, fini sabbiosi o argillosi, talora laminati, raramente cementati (depositi di contatto glaciale). Limiti inferiori sabbiosi o argillosi su substrato roccioso. Limiti superiori coincidono con la superficie topografica o inconfine con SGD<sub>1</sub>, SGD<sub>2</sub>, SGD<sub>3</sub>, SGD<sub>4</sub>, SGD<sub>5</sub>, SGD<sub>6</sub>, SGD<sub>7</sub>, SGD<sub>8</sub>, SGD<sub>9</sub>, SGD<sub>10</sub>, SGD<sub>11</sub>, SGD<sub>12</sub>, SGD<sub>13</sub>, SGD<sub>14</sub>, SGD<sub>15</sub>, SGD<sub>16</sub>, SGD<sub>17</sub>, SGD<sub>18</sub>, SGD<sub>19</sub>, SGD<sub>20</sub>, SGD<sub>21</sub>, SGD<sub>22</sub>, SGD<sub>23</sub>, SGD<sub>24</sub>, SGD<sub>25</sub>, SGD<sub>26</sub>, SGD<sub>27</sub>, SGD<sub>28</sub>, SGD<sub>29</sub>, SGD<sub>30</sub>, SGD<sub>31</sub>, SGD<sub>32</sub>, SGD<sub>33</sub>, SGD<sub>34</sub>, SGD<sub>35</sub>, SGD<sub>36</sub>, SGD<sub>37</sub>, SGD<sub>38</sub>, SGD<sub>39</sub>, SGD<sub>40</sub>, SGD<sub>41</sub>, SGD<sub>42</sub>, SGD<sub>43</sub>, SGD<sub>44</sub>, SGD<sub>45</sub>, SGD<sub>46</sub>, SGD<sub>47</sub>, SGD<sub>48</sub>, SGD<sub>49</sub>, SGD<sub>50</sub>, SGD<sub>51</sub>, SGD<sub>52</sub>, SGD<sub>53</sub>, SGD<sub>54</sub>, SGD<sub>55</sub>, SGD<sub>56</sub>, SGD<sub>57</sub>, SGD<sub>58</sub>, SGD<sub>59</sub>, SGD<sub>60</sub>, SGD<sub>61</sub>, SGD<sub>62</sub>, SGD<sub>63</sub>, SGD<sub>64</sub>, SGD<sub>65</sub>, SGD<sub>66</sub>, SGD<sub>67</sub>, SGD<sub>68</sub>, SGD<sub>69</sub>, SGD<sub>70</sub>, SGD<sub>71</sub>, SGD<sub>72</sub>, SGD<sub>73</sub>, SGD<sub>74</sub>, SGD<sub>75</sub>, SGD<sub>76</sub>, SGD<sub>77</sub>, SGD<sub>78</sub>, SGD<sub>79</sub>, SGD<sub>80</sub>, SGD<sub>81</sub>, SGD<sub>82</sub>, SGD<sub>83</sub>, SGD<sub>84</sub>, SGD<sub>85</sub>, SGD<sub>86</sub>, SGD<sub>87</sub>, SGD<sub>88</sub>, SGD<sub>89</sub>, SGD<sub>90</sub>, SGD<sub>91</sub>, SGD<sub>92</sub>, SGD<sub>93</sub>, SGD<sub>94</sub>, SGD<sub>95</sub>, SGD<sub>96</sub>, SGD<sub>97</sub>, SGD<sub>98</sub>, SGD<sub>99</sub>, SGD<sub>100</sub>, SGD<sub>101</sub>, SGD<sub>102</sub>, SGD<sub>103</sub>, SGD<sub>104</sub>, SGD<sub>105</sub>, SGD<sub>106</sub>, SGD<sub>107</sub>, SGD<sub>108</sub>, SGD<sub>109</sub>, SGD<sub>110</sub>, SGD<sub>111</sub>, SGD<sub>112</sub>, SGD<sub>113</sub>, SGD<sub>114</sub>, SGD<sub>115</sub>, SGD<sub>116</sub>, SGD<sub>117</sub>, SGD<sub>118</sub>, SGD<sub>119</sub>, SGD<sub>120</sub>, SGD<sub>121</sub>, SGD<sub>122</sub>, SGD<sub>123</sub>, SGD<sub>124</sub>, SGD<sub>125</sub>, SGD<sub>126</sub>, SGD<sub>127</sub>, SGD<sub>128</sub>, SGD<sub>129</sub>, SGD<sub>130</sub>, SGD<sub>131</sub>, SGD<sub>132</sub>, SGD<sub>133</sub>, SGD<sub>134</sub>, SGD<sub>135</sub>, SGD<sub>136</sub>, SGD<sub>137</sub>, SGD<sub>138</sub>, SGD<sub>139</sub>, SGD<sub>140</sub>, SGD<sub>141</sub>, SGD<sub>142</sub>, SGD<sub>143</sub>, SGD<sub>144</sub>, SGD<sub>145</sub>, SGD<sub>146</sub>, SGD<sub>147</sub>, SGD<sub>148</sub>, SGD<sub>149</sub>, SGD<sub>150</sub>, SGD<sub>151</sub>, SGD<sub>152</sub>, SGD<sub>153</sub>, SGD<sub>154</sub>, SGD<sub>155</sub>, SGD<sub>156</sub>, SGD<sub>157</sub>, SGD<sub>158</sub>, SGD<sub>159</sub>, SGD<sub>160</sub>, SGD<sub>161</sub>, SGD<sub>162</sub>, SGD<sub>163</sub>, SGD<sub>164</sub>, SGD<sub>165</sub>, SGD<sub>166</sub>, SGD<sub>167</sub>, SGD<sub>168</sub>, SGD<sub>169</sub>, SGD<sub>170</sub>, SGD<sub>171</sub>, SGD<sub>172</sub>, SGD<sub>173</sub>, SGD<sub>174</sub>, SGD<sub>175</sub>, SGD<sub>176</sub>, SGD<sub>177</sub>, SGD<sub>178</sub>, SGD<sub>179</sub>, SGD<sub>180</sub>, SGD<sub>181</sub>, SGD<sub>182</sub>, SGD<sub>183</sub>, SGD<sub>184</sub>, SGD<sub>185</sub>, SGD<sub>186</sub>, SGD<sub>187</sub>, SGD<sub>188</sub>, SGD<sub>189</sub>, SGD<sub>190</sub>, SGD<sub>191</sub>, SGD<sub>192</sub>, SGD<sub>193</sub>, SGD<sub>194</sub>, SGD<sub>195</sub>, SGD<sub>196</sub>, SGD<sub>197</sub>, SGD<sub>198</sub>, SGD<sub>199</sub>, SGD<sub>200</sub>, SGD<sub>201</sub>, SGD<sub>202</sub>, SGD<sub>203</sub>, SGD<sub>204</sub>, SGD<sub>205</sub>, SGD<sub>206</sub>, SGD<sub>207</sub>, SGD<sub>208</sub>, SGD<sub>209</sub>, SGD<sub>210</sub>, SGD<sub>211</sub>, SGD<sub>212</sub>, SGD<sub>213</sub>, SGD<sub>214</sub>, SGD<sub>215</sub>, SGD<sub>216</sub>, SGD<sub>217</sub>, SGD<sub>218</sub>, SGD<sub>219</sub>, SGD<sub>220</sub>, SGD<sub>221</sub>, SGD<sub>222</sub>, SGD<sub>223</sub>, SGD<sub>224</sub>, SGD<sub>225</sub>, SGD<sub>226</sub>, SGD<sub>227</sub>, SGD<sub>228</sub>, SGD<sub>229</sub>, SGD<sub>230</sub>, SGD<sub>231</sub>, SGD<sub>232</sub>, SGD<sub>233</sub>, SGD<sub>234</sub>, SGD<sub>235</sub>, SGD<sub>236</sub>, SGD<sub>237</sub>, SGD<sub>238</sub>, SGD<sub>239</sub>, SGD<sub>240</sub>, SGD<sub>241</sub>, SGD<sub>242</sub>, SGD<sub>243</sub>, SGD<sub>244</sub>, SGD<sub>245</sub>, SGD<sub>246</sub>, SGD<sub>247</sub>, SGD<sub>248</sub>, SGD<sub>249</sub>, SGD<sub>250</sub>, SGD<sub>251</sub>, SGD<sub>252</sub>, SGD<sub>253</sub>, SGD<sub>254</sub>, SGD<sub>255</sub>, SGD<sub>256</sub>, SGD<sub>257</sub>, SGD<sub>258</sub>, SGD<sub>259</sub>, SGD<sub>260</sub>, SGD<sub>261</sub>, SGD<sub>262</sub>, SGD<sub>263</sub>, SGD<sub>264</sub>, SGD<sub>265</sub>, SGD<sub>266</sub>, SGD<sub>267</sub>, SGD<sub>268</sub>, SGD<sub>269</sub>, SGD<sub>270</sub>, SGD<sub>271</sub>, SGD<sub>272</sub>, SGD<sub>273</sub>, SGD<sub>274</sub>, SGD<sub>275</sub>, SGD<sub>276</sub>, SGD<sub>277</sub>, SGD<sub>278</sub>, SGD<sub>279</sub>, SGD<sub>280</sub>, SGD<sub>281</sub>, SGD<sub>282</sub>, SGD<sub>283</sub>, SGD<sub>284</sub>, SGD<sub>285</sub>, SGD<sub>286</sub>, SGD<sub>287</sub>, SGD<sub>288</sub>, SGD<sub>289</sub>, SGD<sub>290</sub>, SGD<sub>291</sub>, SGD<sub>292</sub>, SGD<sub>293</sub>, SGD<sub>294</sub>, SGD<sub>295</sub>, SGD<sub>296</sub>, SGD<sub>297</sub>, SGD<sub>298</sub>, SGD<sub>299</sub>, SGD<sub>300</sub>, SGD<sub>301</sub>, SGD<sub>302</sub>, SGD<sub>303</sub>, SGD<sub>304</sub>, SGD<sub>305</sub>, SGD<sub>306</sub>, SGD<sub>307</sub>, SGD<sub>308</sub>, SGD<sub>309</sub>, SGD<sub>310</sub>, SGD<sub>311</sub>, SGD<sub>312</sub>, SGD<sub>313</sub>, SGD<sub>314</sub>, SGD<sub>315</sub>, SGD<sub>316</sub>, SGD<sub>317</sub>, SGD<sub>318</sub>, SGD<sub>319</sub>, SGD<sub>320</sub>, SGD<sub>321</sub>, SGD<sub>322</sub>, SGD<sub>323</sub>, SGD<sub>324</sub>, SGD<sub>325</sub>, SGD<sub>326</sub>, SGD<sub>327</sub>, SGD<sub>328</sub>, SGD<sub>329</sub>, SGD<sub>330</sub>, SGD<sub>331</sub>, SGD<sub>332</sub>, SGD<sub>333</sub>, SGD<sub>334</sub>, SGD<sub>335</sub>, SGD<sub>336</sub>, SGD<sub>337</sub>, SGD<sub>338</sub>, SGD<sub>339</sub>, SGD<sub>340</sub>, SGD<sub>341</sub>, SGD<sub>342</sub>, SGD<sub>343</sub>, SGD<sub>344</sub>, SGD<sub>345</sub>, SGD<sub>346</sub>, SGD<sub>347</sub>, SGD<sub>348</sub>, SGD<sub>349</sub>, SGD<sub>350</sub>, SGD<sub>351</sub>, SGD<sub>352</sub>, SGD<sub>353</sub>, SGD<sub>354</sub>, SGD<sub>355</sub>, SGD<sub>356</sub>, SGD<sub>357</sub>, SGD<sub>358</sub>, SGD<sub>359</sub>, SGD<sub>360</sub>, SGD<sub>361</sub>, SGD<sub>362</sub>, SGD<sub>363</sub>, SGD<sub>364</sub>, SGD<sub>365</sub>, SGD<sub>366</sub>, SGD<sub>367</sub>, SGD<sub>368</sub>, SGD<sub>369</sub>, SGD<sub>370</sub>, SGD<sub>371</sub>, SGD<sub>372</sub>, SGD<sub>373</sub>, SGD<sub>374</sub>, SGD<sub>375</sub>, SGD<sub>376</sub>, SGD<sub>377</sub>, SGD<sub>378</sub>, SGD<sub>379</sub>, SGD<sub>380</sub>, SGD<sub>381</sub>, SGD<sub>382</sub>, SGD<sub>383</sub>, SGD<sub>384</sub>, SGD<sub>385</sub>, SGD<sub>386</sub>, SGD<sub>387</sub>, SGD<sub>388</sub>, SGD<sub>389</sub>, SGD<sub>390</sub>, SGD<sub>391</sub>, SGD<sub>392</sub>, SGD<sub>393</sub>, SGD<sub>394</sub>, SGD<sub>395</sub>, SGD<sub>396</sub>, SGD<sub>397</sub>, SGD<sub>398</sub>, SGD<sub>399</sub>, SGD<sub>400</sub>, SGD<sub>401</sub>, SGD<sub>402</sub>, SGD<sub>403</sub>, SGD<sub>404</sub>, SGD<sub>405</sub>, SGD<sub>406</sub>, SGD<sub>407</sub>, SGD<sub>408</sub>, SGD<sub>409</sub>, SGD<sub>410</sub>, SGD<sub>411</sub>, SGD<sub>412</sub>, SGD<sub>413</sub>, SGD<sub>414</sub>, SGD<sub>415</sub>, SGD<sub>416</sub>, SGD<sub>417</sub>, SGD<sub>418</sub>, SGD<sub>419</sub>, SGD<sub>420</sub>, SGD<sub>421</sub>, SGD<sub>422</sub>, SGD<sub>423</sub>, SGD<sub>424</sub>, SGD<sub>425</sub>, SGD<sub>426</sub>, SGD<sub>427</sub>, SGD<sub>428</sub>, SGD<sub>429</sub>, SGD<sub>430</sub>, SGD<sub>431</sub>, SGD<sub>432</sub>, SGD<sub>433</sub>, SGD<sub>434</sub>, SGD<sub>435</sub>, SGD<sub>436</sub>, SGD<sub>437</sub>, SGD<sub>438</sub>, SGD<sub>439</sub>, SGD<sub>440</sub>, SGD<sub>441</sub>, SGD<sub>442</sub>, SGD<sub>443</sub>, SGD<sub>444</sub>, SGD<sub>445</sub>, SGD<sub>446</sub>, SGD<sub>447</sub>, SGD<sub>448</sub>, SGD<sub>449</sub>, SGD<sub>450</sub>, SGD<sub>451</sub>, SGD<sub>452</sub>, SGD<sub>453</sub>, SGD<sub>454</sub>, SGD<sub>455</sub>, SGD<sub>456</sub>, SGD<sub>457</sub>, SGD<sub>458</sub>, SGD<sub>459</sub>, SGD<sub>460</sub>, SGD<sub>461</sub>, SGD<sub>462</sub>, SGD<sub>463</sub>, SGD<sub>464</sub>, SGD<sub>465</sub>, SGD<sub>466</sub>, SGD<sub>467</sub>, SGD<sub>468</sub>, SGD<sub>469</sub>, SGD<sub>470</sub>, SGD<sub>471</sub>, SGD<sub>472</sub>, SGD<sub>473</sub>, SGD<sub>474</sub>, SGD<sub>475</sub>, SGD<sub>476</sub>, SGD<sub>477</sub>, SGD<sub>478</sub>, SGD<sub>479</sub>, SGD<sub>480</sub>, SGD<sub>481</sub>, SGD<sub>482</sub>, SGD<sub>483</sub>, SGD<sub>484</sub>, SGD<sub>485</sub>, SGD<sub>486</sub>, SGD<sub>487</sub>, SGD<sub>488</sub>, SGD<sub>489</sub>, SGD<sub>490</sub>, SGD<sub>491</sub>, SGD<sub>492</sub>, SGD<sub>493</sub>, SGD<sub>494</sub>, SGD<sub>495</sub>, SGD<sub>496</sub>, SGD<sub>497</sub>, SGD<sub>498</sub>, SGD<sub>499</sub>, SGD<sub>500</sub>, SGD<sub>501</sub>, SGD<sub>502</sub>, SGD<sub>503</sub>, SGD<sub>504</sub>, SGD<sub>505</sub>, SGD<sub>506</sub>, SGD<sub>507</sub>, SGD<sub>508</sub>, SGD<sub>509</sub>, SGD<sub>510</sub>, SGD<sub>511</sub>, SGD<sub>512</sub>, SGD<sub>513</sub>, SGD<sub>514</sub>, SGD<sub>515</sub>, SGD<sub>516</sub>, SGD<sub>517</sub>, SGD<sub>518</sub>, SGD<sub>519</sub>, SGD<sub>520</sub>, SGD<sub>521</sub>, SGD<sub>522</sub>, SGD<sub>523</sub>, SGD<sub>524</sub>, SGD<sub>525</sub>, SGD<sub>526</sub>, SGD<sub>527</sub>, SGD<sub>528</sub>, SGD<sub>529</sub>, SGD<sub>530</sub>, SGD<sub>531</sub>, SGD<sub>532</sub>, SGD<sub>533</sub>, SGD<sub>534</sub>, SGD<sub>535</sub>, SGD<sub>536</sub>, SGD<sub>537</sub>, SGD<sub>538</sub>, SGD<sub>539</sub>, SGD<sub>540</sub>, SGD<sub>541</sub>, SGD<sub>542</sub>, SGD<sub>543</sub>, SGD<sub>544</sub>, SGD<sub>545</sub>, SGD<sub>546</sub>, SGD<sub>547</sub>, SGD<sub>548</sub>, SGD<sub>549</sub>, SGD<sub>550</sub>, SGD<sub>551</sub>, SGD<sub>552</sub>, SGD<sub>553</sub>, SGD<sub>554</sub>, SGD<sub>555</sub>, SGD<sub>556</sub>, SGD<sub>557</sub>, SGD<sub>558</sub>, SGD<sub>559</sub>, SGD<sub>560</sub>, SGD<sub>561</sub>, SGD<sub>562</sub>, SGD<sub>563</sub>, SGD<sub>564</sub>, SGD<sub>565</sub>, SGD<sub>566</sub>, SGD<sub>567</sub>, SGD<sub>568</sub>, SGD<sub>569</sub>, SGD<sub>570</sub>, SGD<sub>571</sub>, SGD<sub>572</sub>, SGD<sub>573</sub>, SGD<sub>574</sub>, SGD<sub>575</sub>, SGD<sub>576</sub>, SGD<sub>577</sub>, SGD<sub>578</sub>, SGD<sub>579</sub>, SGD<sub>580</sub>, SGD<sub>581</sub>, SGD<sub>582</sub>, SGD<sub>583</sub>, SGD<sub>584</sub>, SGD<sub>585</sub>, SGD<sub>586</sub>, SGD<sub>587</sub>, SGD<sub>588</sub>, SGD<sub>589</sub>, SGD<sub>590</sub>, SGD<sub>591</sub>, SGD<sub>592</sub>, SGD<sub>593</sub>, SGD<sub>594</sub>, SGD<sub>595</sub>, SGD<sub>596</sub>, SGD<sub>597</sub>, SGD<sub>598</sub>, SGD<sub>599</sub>, SGD<sub>600</sub>, SGD<sub>601</sub>, SGD<sub>602</sub>, SGD<sub>603</sub>, SGD<sub>604</sub>, SGD<sub>605</sub>, SGD<sub>606</sub>, SGD<sub>607</sub>, SGD<sub>608</sub>, SGD<sub>609</sub>, SGD<sub>610</sub>, SGD<sub>611</sub>, SGD<sub>612</sub>, SGD<sub>613</sub>, SGD<sub>614</sub>, SGD<sub>615</sub>, SGD<sub>616</sub>, SGD<sub>617</sub>, SGD<sub>618</sub>, SGD<sub>619</sub>, SGD<sub>620</sub>, SGD<sub>621</sub>, SGD<sub>622</sub>, SGD<sub>623</sub>, SGD<sub>624</sub>, SGD<sub>625</sub>, SGD<sub>626</sub>, SGD<sub>627</sub>, SGD<sub>628</sub>, SGD<sub>629</sub>, SGD<sub>630</sub>, SGD<sub>631</sub>, SGD<sub>632</sub>, SGD<sub>633</sub>, SGD<sub>634</sub>, SGD<sub>635</sub>, SGD<sub>636</sub>, SGD<sub>637</sub>, SGD<sub>638</sub>, SGD<sub>639</sub>, SGD<sub>640</sub>, SGD<sub>641</sub>, SGD<sub>642</sub>, SGD<sub>643</sub>, SGD<sub>644</sub>, SGD<sub>645</sub>, SGD<sub>646</sub>, SGD<sub>647</sub>, SGD<sub>648</sub>, SGD<sub>649</sub>, SGD<sub>650</sub>, SGD<sub>651</sub>, SGD<sub>652</sub>, SGD<sub>653</sub>, SGD<sub>654</sub>, SGD<sub>655</sub>, SGD<sub>656</sub>, SGD<sub>657</sub>, SGD<sub>658</sub>, SGD<sub>659</sub>, SGD<sub>660</sub>, SGD<sub>661</sub>, SGD<sub>662</sub>, SGD<sub>663</sub>, SGD<sub>664</sub>, SGD<sub>665</sub>, SGD<sub>666</sub>, SGD<sub>667</sub>, SGD<sub>668</sub>, SGD<sub>669</sub>, SGD<sub>670</sub>, SGD<sub>671</sub>, SGD<sub>672</sub>, SGD<sub>673</sub>, SGD<sub>674</sub>, SGD<sub>675</sub>, SGD<sub>676</sub>, SGD<sub>677</sub>, SGD<sub>678</sub>, SGD<sub>679</sub>, SGD<sub>680</sub>, SGD<sub>681</sub>, SGD<sub>682</sub>, SGD<sub>683</sub>, SGD<sub>684</sub>, SGD<sub>685</sub>, SGD<sub>686</sub>, SGD<sub>687</sub>, SGD<sub>688</sub>, SGD<sub>689</sub>, SGD<sub>690</sub>, SGD<sub>691</sub>, SGD<sub>692</sub>, SGD<sub>693</sub>, SGD<sub>694</sub>, SGD<sub>695</sub>, SGD<sub>696</sub>, SGD<sub>697</sub>, SGD<sub>698</sub>, SGD<sub>699</sub>, SGD<sub>700</sub>, SGD<sub>701</sub>, SGD<sub>702</sub>, SGD<sub>703</sub>, SGD<sub>704</sub>, SGD<sub>705</sub>, SGD<sub>706</sub>, SGD<sub>707</sub>, SGD<sub>708</sub>, SGD<sub>709</sub>, SGD<sub>710</sub>, SGD<sub>711</sub>, SGD<sub>712</sub>, SGD<sub>713</sub>, SGD<sub>714</sub>, SGD<sub>715</sub>, SGD<sub>716</sub>, SGD<sub>717</sub>, SGD<sub>718</sub>, SGD<sub>719</sub>, SGD<sub>720</sub>, SGD<sub>721</sub>, SGD<sub>722</sub>, SGD<sub>723</sub>, SGD<sub>724</sub>, SGD<sub>725</sub>, SGD<sub>726</sub>, SGD<sub>727</sub>, SGD<sub>728</sub>, SGD<sub>729</sub>, SGD<sub>730</sub>, SGD<sub>731</sub>, SGD<sub>732</sub>, SGD<sub>733</sub>, SGD<sub>734</sub>, SGD<sub>735</sub>, SGD<sub>736</sub>, SGD<sub>737</sub>, SGD<sub>738</sub>, SGD<sub>739</sub>, SGD<sub>740</sub>, SGD<sub>741</sub>, SGD<sub>742</sub>, SGD<sub>743</sub>, SGD<sub>744</sub>, SGD<sub>745</sub>, SGD<sub>746</sub>, SGD<sub>747</sub>, SGD<sub>748</sub>, SGD<sub>749</sub>, SGD<sub>750</sub>, SGD<sub>751</sub>, SGD<sub>752</sub>, SGD<sub>753</sub>, SGD<sub>754</sub>, SGD<sub>755</sub>, SGD<sub>756</sub>, SGD<sub>757</sub>, SGD<sub>758</sub>, SGD<sub>759</sub>, SGD<sub>760</sub>, SGD<sub>761</sub>, SGD<sub>762</sub>, SGD<sub>763</sub>, SGD<sub>764</sub>, SGD<sub>765</sub>, SGD<sub>766</sub>, SGD<sub>767</sub>, SGD<sub>768</sub>, SGD<sub>769</sub>, SGD<sub>770</sub>, SGD<sub>771</sub>, SGD<sub>772</sub>, SGD<sub>773</sub>, SGD<sub>774</sub>, SGD<sub>775</sub>, SGD<sub>776</sub>, SGD<sub>777</sub>, SGD<sub>778</sub>, SGD<sub>779</sub>, SGD<sub>780</sub>, SGD<sub>781</sub>, SGD<sub>782</sub>, SGD<sub>783</sub>, SGD<sub>784</sub>, SGD<sub>785</sub>, SGD<sub>786</sub>, SGD<sub>787</sub>, SGD<sub>788</sub>, SGD<sub>789</sub>, SGD<sub>790</sub>, SGD<sub>791</sub>, SGD<sub>792</sub>, SGD<sub>793</sub>, SGD<sub>794</sub>, SGD<sub>795</sub>, SGD<sub>796</sub>, SGD<sub>797</sub>, SGD<sub>798</sub>, SGD<sub>799</sub>, SGD<sub>800</sub>, SGD<sub>801</sub>, SGD<sub>802</sub>, SGD<sub>803</sub>, SGD<sub>804</sub>, SGD<sub>805</sub>, SGD<sub>806</sub>, SGD<sub>807</sub>, SGD<sub>808</sub>, SGD<sub>809</sub>, SGD<sub>810</sub>, SGD<sub>811</sub>, SGD<sub>812</sub>, SGD<sub>813</sub>, SGD<sub>814</sub>, SGD<sub>815</sub>, SGD<sub>816</sub>, SGD<sub>817</sub>, SGD<sub>818</sub>, SGD<sub>819</sub>, SGD<sub>820</sub>, SGD<sub>821</sub>, SGD<sub>822</sub>, SGD<sub>823</sub>, SGD<sub>824</sub>, SGD<sub>825</sub>, SGD<sub>826</sub>, SGD<sub>827</sub>, SGD<sub>828</sub>, SGD<sub>829</sub>, SGD<sub>830</sub>, SGD<sub>831</sub>, SGD<sub>832</sub>, SGD<sub>833</sub>, SGD<sub>834</sub>, SGD<sub>835</sub>, SGD<sub>836</sub>, SGD<sub>837</sub>, SGD<sub>838</sub>, SGD<sub>839</sub>, SGD<sub>840</sub>, SGD<sub>841</sub>, SGD<sub>842</sub>, SGD<sub>843</sub>, SGD<sub>844</sub>, SGD<sub>845</sub>, SGD<sub>846</sub>, SGD<sub>847</sub>, SGD<sub>848</sub>, SGD<sub>849</sub>, SGD<sub>850</sub>, SGD<sub>851</sub>, SGD<sub>852</sub>, SGD<sub>853</sub>, SGD<sub>854</sub>, SGD<sub>855</sub>, SGD<sub>856</sub>, SGD<sub>857</sub>, SGD<sub>858</sub>, SGD<sub>859</sub>, SGD<sub>860</sub>, SGD<sub>861</sub>, SGD<sub>862</sub>, SGD<sub>863</sub>, SGD<sub>864</sub>, SGD<sub>865</sub>, SGD<sub>866</sub>, SGD<sub>867</sub>, SGD<sub>868</sub>, SGD<sub>869</sub>, SGD<sub>870</sub>, SGD<sub>871</sub>, SGD<sub>872</sub>, SGD<sub>873</sub>, SGD<sub>874</sub>, SGD<sub>875</sub>, SGD<sub>876</sub>, SGD<sub>877</sub>, SGD<sub>878</sub>, SGD<sub>879</sub>, SGD<sub>880</sub>, SGD<sub>881</sub>, SGD<sub>882</sub>, SGD<sub>883</sub>, SGD<sub>884</sub>, SGD<sub>885</sub>, SGD<sub>886</sub>, SGD<sub>887</sub>, SGD<sub>888</sub>, SGD<sub>889</sub>, SGD<sub>890</sub>, SGD<sub>891</sub>, SGD<sub>892</sub>, SGD<sub>893</sub>, SGD<sub>894</sub>, SGD<sub>895</sub>, SGD<sub>896</sub>, SGD<sub>897</sub>, SGD<sub>898</sub>, SGD<sub>899</sub>, SGD<sub>900</sub>, SGD<sub>901</sub>, SGD<sub>902</sub>, SGD<sub>903</sub>, SGD<sub>904</sub>, SGD<sub>905</sub>, SGD<sub>906</sub>, SGD<sub>907</sub>, SGD<sub>908</sub>, SGD<sub>909</sub>, SGD<sub>910</sub>, SGD<sub>911</sub>, SGD<sub>912</sub>, SGD<sub>913</sub>, SGD<sub>914</sub>, SGD<sub>915</sub>, SGD<sub>916</sub>, SGD<sub>917</sub>, SGD<sub>918</sub>, SGD<sub>919</sub>, SGD<sub>920</sub>, SGD<sub>921</sub>, SGD<sub>922</sub>, SGD<sub>923</sub>, SGD<sub>924</sub>, SGD<sub>925</sub>, SGD<sub>926</sub>, SGD<sub>927</sub>, SGD<sub>928</sub>, SGD<sub>929</sub>, SGD<sub>930</sub>, SGD<sub>931</sub>, SGD<sub>932</sub>, SGD<sub>933</sub>, SGD<sub>934</sub>, SGD<sub>935</sub>, SGD<sub>936</sub>, SGD<sub>937</sub>, SGD<sub>938</sub>, SGD<sub>939</sub>, SGD<sub>940</sub>, SGD<sub>941</sub>, SGD<sub>942</sub>, SGD<sub>943</sub>, SGD<sub>944</sub>, SGD<sub>945</sub>, SGD<sub>946</sub>, SGD<sub>947</sub>, SGD<sub>948</sub>, SGD<sub>949</sub>, SGD<sub>950</sub>, SGD<sub>951</sub>, SGD<sub>952</sub>, SGD<sub>953</sub>, SGD<sub>954</sub>, SGD<sub>955</sub>, SGD<sub>956</sub>, SGD<sub>957</sub>, SGD<sub>958</sub>, SGD<sub>959</sub>, SGD<sub>960</sub>, SGD<sub>961</sub>, SGD<sub>962</sub>, SGD<sub>963</sub>, SGD<sub>964</sub>, SGD<sub>965</sub>, SGD<sub>966</sub>, SGD<sub>967</sub>, SGD<sub>968</sub>, SGD<sub>969</sub>, SGD<sub>970</sub>, SGD<sub>971</sub>, SGD<sub>972</sub>, SGD<sub>973</sub>, SGD<sub>974</sub>, SGD<sub>975</sub>, SGD<sub>976</sub>, SGD<sub>977</sub>, SGD<sub>978</sub>, SGD<sub>979</sub>, SGD<sub>980</sub>, SGD<sub>981</sub>, SGD<sub>982</sub>, SGD<sub>983</sub>, SGD<sub>984</sub>, SGD<sub>985</sub>, SGD<sub>986</sub>, SGD<sub>987</sub>, SGD<sub>988</sub>, SGD<sub>989</sub>, SGD<sub>990</sub>, SGD<sub>991</sub>, SGD<sub>992</sub>, SGD<sub>993</sub>, SGD<sub>994</sub>, SGD<sub>995</sub>, SGD<sub>996</sub>, SGD<sub>997</sub>, SGD<sub>998</sub>, SGD<sub>999</sub>, SGD<sub>1000</sub>, SGD<sub>1001</sub>, SGD<sub>1002</sub>, SGD<sub>1003</sub>, SGD<sub>1004</sub>, SGD<sub>1005</sub>, SGD<sub>1006</sub>, SGD<sub>1007</sub>, SGD<sub>1008</sub>, SGD<sub>1009</sub>, SGD<sub>1010</sub>, SGD<sub>1011</sub>, SGD<sub>1012</sub>, SGD<sub>1013</sub>, SGD<sub>1014</sub>, SGD<sub>1015</sub>, SGD<sub>1016</sub>, SGD<sub>1017</sub>, SGD<sub>1018</sub>, SGD<sub>1019</sub>, SGD<sub>1020</sub>, SGD<sub>1021</sub>, SGD<sub>1022</sub>, SGD<sub>1023</sub>, SGD<sub>1024</sub>, SGD<sub>1025</sub>, SGD<sub>1026</sub>, SGD<sub>1027</sub>, SGD<sub>1028</sub>, SGD<sub>1029</sub>, SGD<sub>1030</sub>, SGD<sub>1031</sub>, SGD<sub>1032</sub>, SGD<sub>1033</sub>, SGD<sub>1034</sub>, SGD<sub>1035</sub>, SGD<sub>1036</sub>, SGD<sub>1037</sub>, SGD<sub>1038</sub>, SGD<sub>1039</sub>, SGD<sub>1040</sub>, SGD<sub>1041</sub>, SGD<sub>1042</sub>, SGD<sub>1043</sub>, SGD<sub>1044</sub>, SGD<sub>1045</sub>, SGD<sub>1046</sub>, SGD<sub>1047</sub>, SGD<sub>1048</sub>, SGD<sub>1049</sub>, SGD<sub>1050</sub>, SGD<sub>1051</sub>, SGD<sub>1052</sub>, SGD<sub>1053</sub>, SGD<sub>1054</sub>, SGD<sub>1055</sub>, SGD<sub>1056</sub>, SGD<sub>1057</sub>, SGD<sub>1058</sub>, SGD<sub>1059</sub>, SGD<sub>1060</sub>, SGD<sub>1061</sub>, SGD<sub>1062</sub>, SGD<sub>1063</sub>, SGD<sub>1064</sub>, SGD<sub>1065</sub>, SGD<sub>1066</sub>, SGD<sub>1067</sub>, SGD<sub>1068</sub>, SGD<sub>1069</sub>, SGD<sub>1070</sub>, SGD<sub>1071</sub>, SGD<sub>1072</sub>, SGD<sub>1</sub>



# Geländeerhebungen

## KARTE DER AUFSCHLÜSSE CARTA DEGLI AFFIORAMENTI



STOP-01. Se ghetenul, nu este încă suficient îngrijit și trebuie să fie curățat în mod regulat cu apă caldă și săpun.

LEGENDE / LEGENDA

— Straßenschilderung-Hydranten-Projekt • Projekt für Straßenschilderung

## LITHOLOGIE • LITOLÓGIA

Copyright © 2015 John Wiley &amp; Sons, Ltd.

■ **Bentner Konglomerat: Conglomerato di Sesto (Q38)**

Assegnazione dei Sostituenti/Sostituenti / Classificazione dei punti di sostituzione/numerazione  
(XXX = disidrazione / XX = disidrazione)

- **Bildung/Erziehung / Sozialisation**

• **Modelling of the system**

## VERKEHRSGESCH. / REISE UND WERB.

— Alessandro Benvenuti, *Il Sole 24 Ore*

— Landisstraße / Strada provinciale

— Censindistratto / Strada comune

— Gens. str. în Localitatea Lung / Strada comunale în marș. provinciale

— Gitterweg für U62 (Straße potentiell per Wohnort)

— Cile: viaggio per trekking / Strada pedonale per trekking

— Foresta in via di ricostituzione per incendio forestale/colpisce per incendio

— **Forsämringsavgift för Trafikskola** 1000,-  
 — **Reklamationsavgift** 1000,-

Phosphatase + Sugar phosphate  
Lithodendron + Endocrine

Wanderweg: Sandberg

— **Redding:** Made extra in



STC9406: 6802a, deduced from 6802a subgenus, subgenus  
 subgenus 6802a subgenus 6802a subgenus 6802a  
 STC9406: 6802a subgenus 6802a subgenus 6802a  
 subgenus 6802a subgenus 6802a subgenus 6802a



STOP-02: Reinforcing practice of Cephalexin in oral therapy. Following STOP-02, Rouse queried, not given a good answer, asked program to be modified over a year.





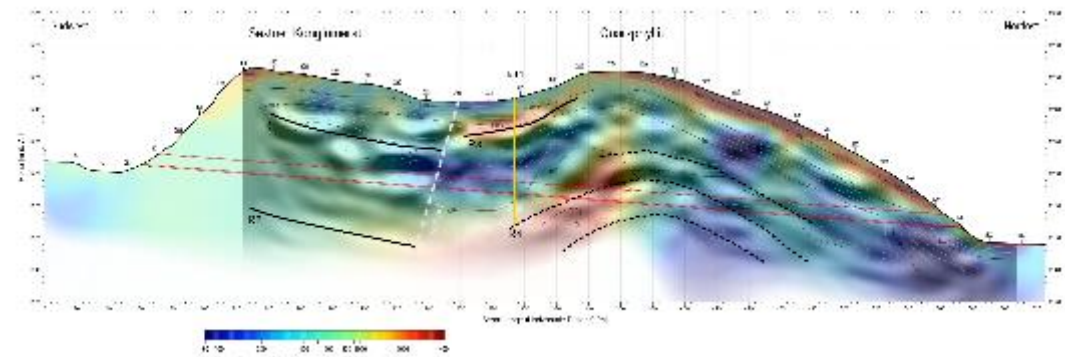




# Durchgeführte Untersuchungen

## • Vorprojekt: I Phase der Untersuchungen

- 1 Zerstörungsbohrung (erreichte Tiefe - 82 m ab G.O.K),
- 1 BHTV,
- verschiedene geophysikalische Untersuchungen



Vorläufige Interpretation der geologischen Strukturen auf der Grundlage der geophysikalischen Untersuchungen.

### LEGENDA / LEGENDA

— Straßenbauliches-Hydraulisches Projekt / Progetto stradale idraulico

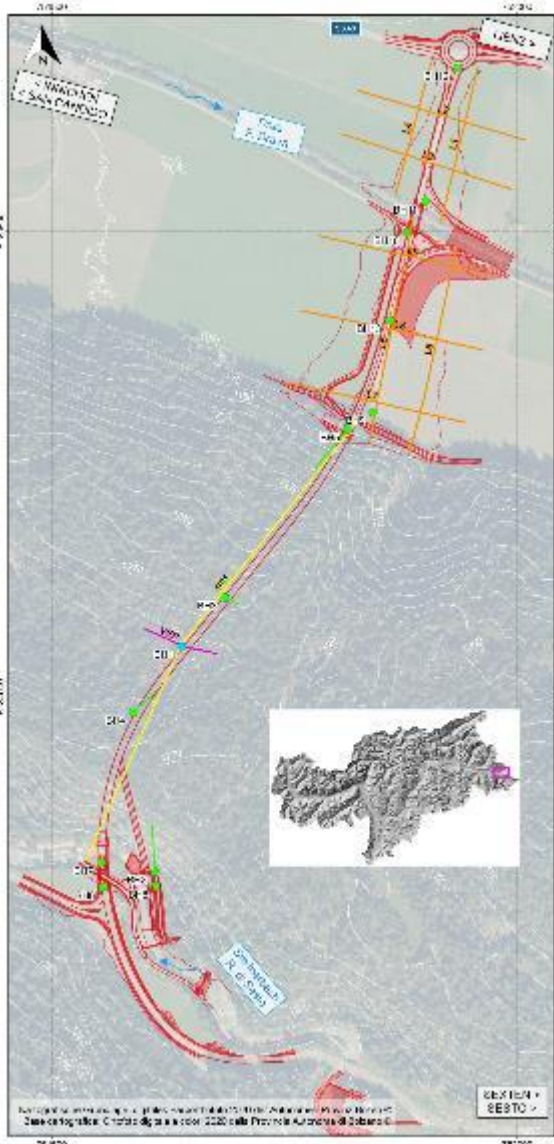
GEOLOGISCHE UNTERSUCHUNGEN, DIE IM RAHMEN DER VORPROJEKTIERUNG DURCHFÜHRT WURDEN  
INDAGINI GEOLOGICHE REALIZZATE IN SEDE DI PROGETTAZIONE PRELIMINARE

- Bohrung / Sondaggio
- Profil P01 (seismische und geoelektrische Untersuchung)  
Stendimento P01 (indagine geofisica sismica ed elettrica)
- Vertikales seismisches Profil (VSP) / Profilo sismico verticale (VSP)

GEOLOGISCHE UNTERSUCHUNGEN, DIE WÄHREND DER EINREICHPLANUNG DURCHFÜHRT WURDEN  
INDAGINI GEOLOGICHE REALIZZATE IN SEDE DI PROGETTAZIONE DEFINITIVA

- Bohrung / Sondaggio
- Profile L1 L9 (Geoelektrische und seismische Untersuchungen)  
Stendimento L1 L9 (indagine geofisica sismica ed elettrica)

Specialisti Altoatesini per San Candido  
Südtiroler Fachgruppe für Innichen





# Durchgeführte Untersuchungen

## • Einreichprojekt: II Phase der Untersuchungen

- 12 Kern-/Zerstörungsbohrungen (max . Tiefe - 92 m ab G.O.K);
- 3 BHTV;
- verschiedene geophysikalische Untersuchungen.

Für die hydrologische und hydrogeologische Charakterisierung des Projektgebietes wurden die folgenden Messungen/Versuche realisiert:

- 2 Serien von Messungen des Wasserstands in 11 verschiedenen Pegelrohren;
- Schüttungsmessungen in 2 Bereiche;
- 2 Lugeonversuche
- hydrochemische Charakterisierung alle Moorgebiete.

### LEGENDE / LEGENDA

— Straßenbauliches-Hydraulisches Projekt / Progetto stradale-idraulico

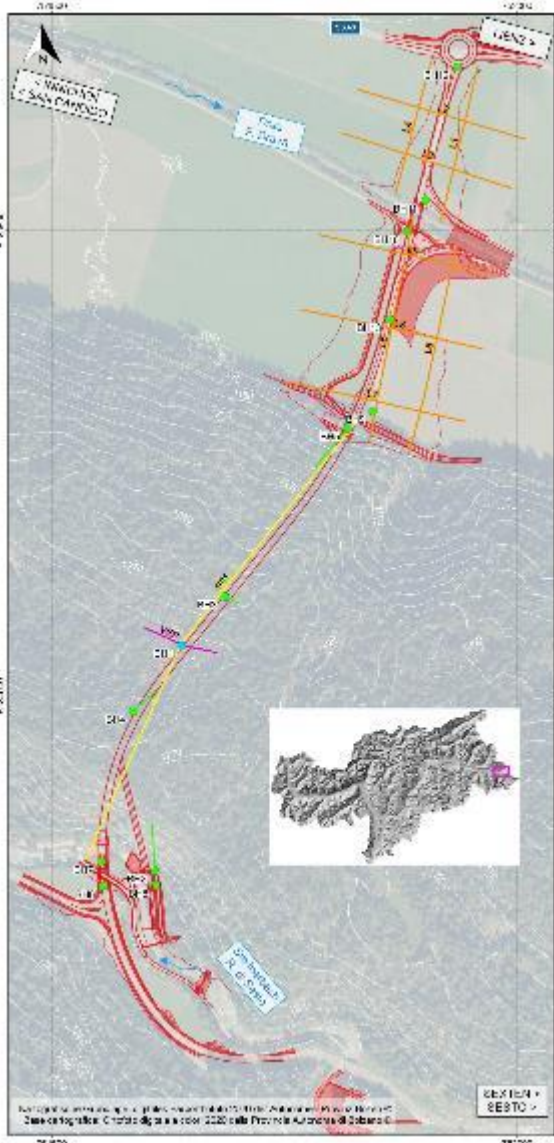
GEOLOGISCHE UNTERSUCHUNGEN, DIE IM RAHMEN DER VORPROJEKTIERUNG DURCHGEFÜHRT WURDEN  
INDAGINI GEOLOGICHE REALIZZATE IN SEDE DI PROGETTAZIONE PRELIMINARE

- Bohrung / Sondaggio
- Profil P01 (seismische und geoelektrische Untersuchung)  
Stendimento P01 (indagine geofisica sismica ed elettrica)
- Vertikales seismisches Profil (VSP) / Profilo sismico verticale (VSP)

GEOLOGISCHE UNTERSUCHUNGEN, DIE WÄHREND DER EINREICHPLANUNG DURCHGEFÜHRT WURDEN  
INDAGINI GEOLOGICHE REALIZZATE IN SEDE DI PROGETTAZIONE DEFINITIVA

- Bohrung / Sondaggio
- Profil L1-L9 (Geoelektrische und seismische Untersuchungen)  
Stendimento L1-L9 (indagine geofisica sismica ed elettrica)

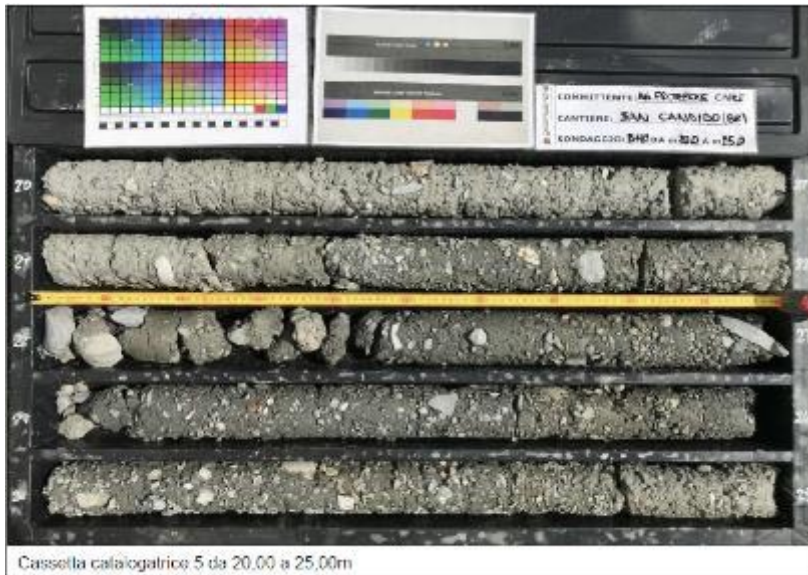
Specialisti Altoatesini per San Candido  
Südtiroler Fachgruppe für Innichen



# Ergebnisse der Untersuchungen

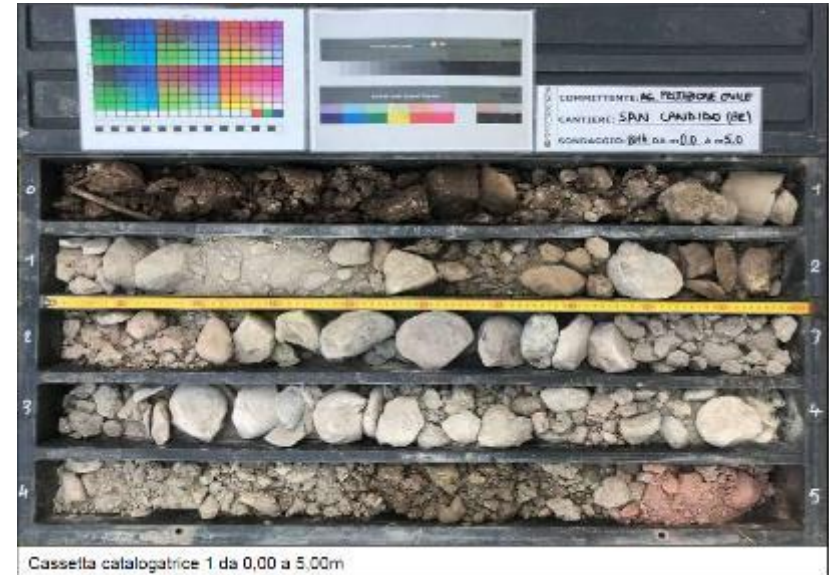
## Geologische Einheiten im Talboden

### Garda – Synthem (SGD)



Moräne undifferenziert (BH 12 Tiefe= 20 - 25 m Seite Drau)

### Alpines Postglaziales Synthem (PTG)



Alluviale Ablagerungen (BH6 Tiefe 0 - 5 m Seite Sexten)



# Ergebnisse der Untersuchungen

## Geologische Einheiten im Tunnel-Bereich

Sextner Konglomerat (CGS)



(BH 4 Tiefe= 55 - 60 m)

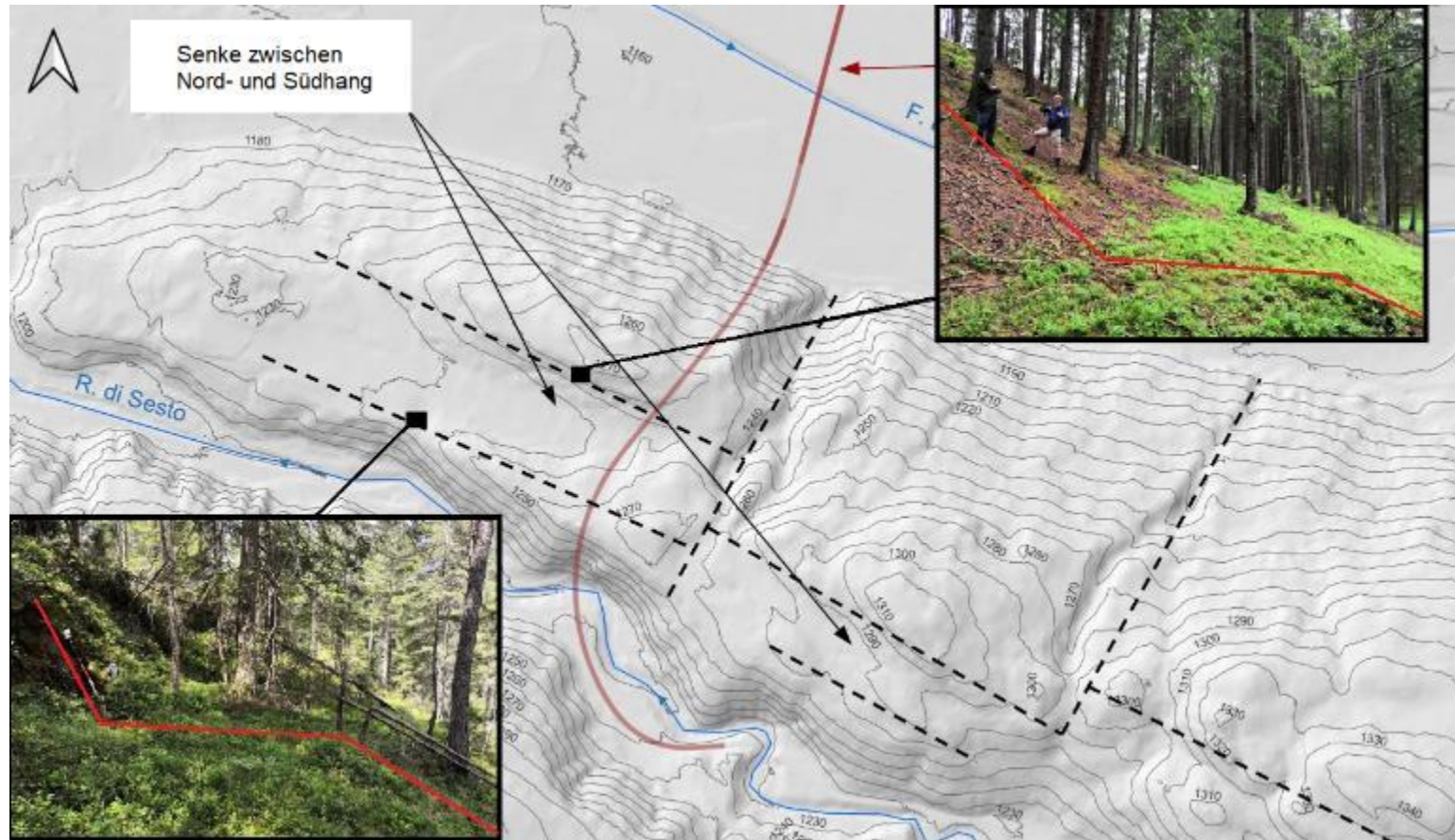
Brixner Quarzphyllit (BBS)



(BH3 Tiefe 78 – 83 m)

# Ergebnisse der Untersuchungen

## Strukturelle Merkmale



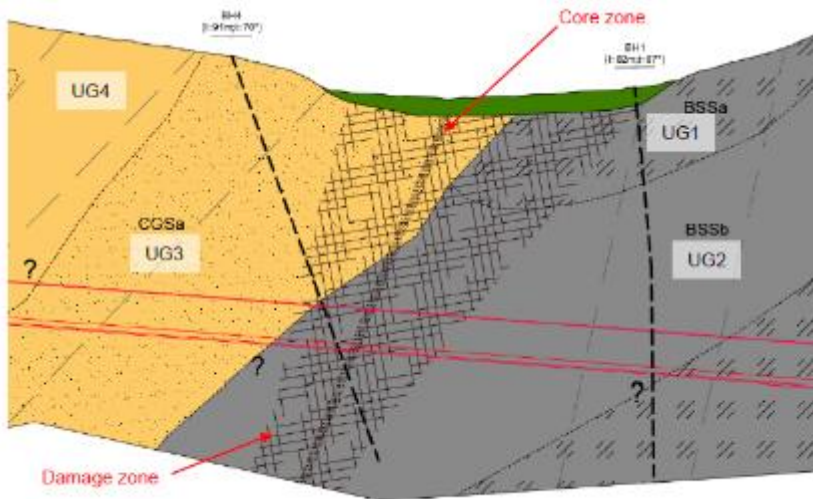
Specialisti Altoatesini per San Candido  
Südtiroler Fachgruppe für Innichen



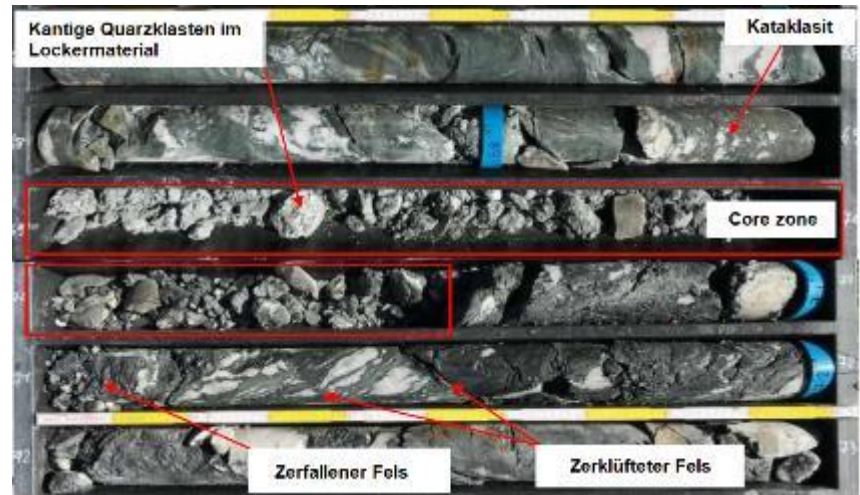
# Ergebnisse der Untersuchungen

## Strukturelle Merkmale

Geschätzte Länge der beschädigten Zone entlang des Tunnels = ca. 60 m

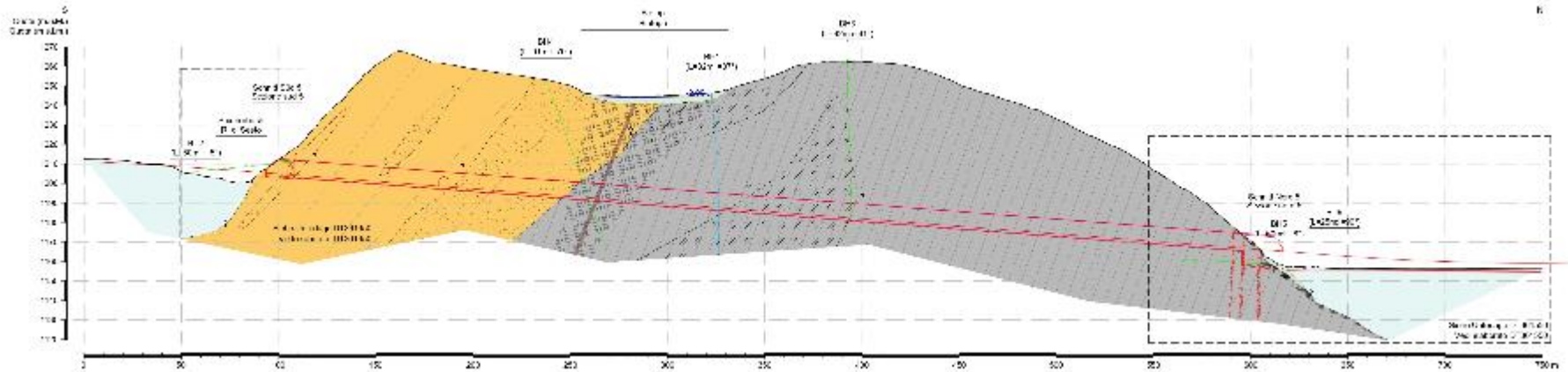


Längsprofil N-S in Bereich der Störungszone



BH4 – Tiefe 67,0 – 73,0 mit Core zone und Damage zone.

# Erstellung des geologischen Modells



Die genaue Festlegung der Wasseraustritte im Tunnel bleibt noch eine offene Frage, welche im Ausführungsprojekt vertieft werden muss.





# Idrologia e Idraulica

1. Dall'analisi idrologica alle forzanti di progetto
2. Lo schema idraulico
3. Fenomenologia e trasporto solido
4. Briglie per la trattenuta del materiale solido e flottante
5. Opera di presa dal rio di Sesto e adduzione in galleria
6. Opera di dissipazione
7. Scarico in Drava

# Dall'analisi idrologica alle forzanti di progetto

Evento Vaia => elaborazione dati, tempo di ritorno dell'evento, portata evento, portata di progetto



| Anno | $Q_{max}$ [ $m^3 s^{-1}$ ] | Anno | $Q_{max}$ [ $m^3 s^{-1}$ ] |
|------|----------------------------|------|----------------------------|
| 1998 | 27.8                       | 2009 | 10.9                       |
| 1999 | 18                         | 2010 | 9.9                        |
| 2000 | 30.2                       | 2011 | 11.8                       |
| 2001 | 10.7                       | 2012 | 20.9                       |
| 2002 | 19.5                       | 2013 | 8.65                       |
| 2003 | 10                         | 2014 | 18.5                       |
| 2004 | 8.98                       | 2015 | 8.9                        |
| 2005 | 12.1                       | 2016 | 11.9                       |
| 2006 | 8.64                       | 2017 | 10.1                       |
| 2007 | 7.84                       | 2018 | 48.4                       |
| 2008 | 13                         | 2019 | 6.28                       |

Massimi annuali di portata registrati a Sesto nel periodo dal 1998 al 2019

| Anno | $Q_{max}$ [ $m^3 s^{-1}$ ] | Anno | $Q_{max}$ [ $m^3 s^{-1}$ ] |
|------|----------------------------|------|----------------------------|
| 1999 | 19.4                       | 2005 | 11.9                       |
| 1999 | 9.8                        | 2006 | 10.3                       |
| 1999 | 17.5                       | 2007 | 9.26                       |
| 1999 | 19.4                       | 2008 | 17.1                       |
| 1999 | 26.2                       | 2009 | 18.1                       |
| 1999 | 14.7                       | 2010 | 17.8                       |
| 1999 | 8.95                       | 2011 | 18.4                       |
| 1999 | 17                         | 2012 | 32                         |
| 1999 | 14.5                       | 2013 | 13.3                       |
| 1999 | 33.7                       | 2014 | 29.1                       |
| 1999 | 19                         | 2015 | 8.848                      |
| 2000 | 34.5                       | 2016 | 14.5                       |
| 2001 | 18.6                       | 2017 | 10.2                       |
| 2002 | 23.5                       | 2018 | 62.8 (65)                  |
| 2003 | 11.7                       | 2019 | 22.2                       |
| 2004 | 10.2                       | -    | -                          |

Massimi annuali di portata registrati a Vescovo nel periodo dal 1999 al 2019

Arnabach

| Anno | $Q_{max}$ [ $m^3 s^{-1}$ ] | Anno | $Q_{max}$ [ $m^3 s^{-1}$ ] |
|------|----------------------------|------|----------------------------|
| 1998 | 30.22                      | 2009 | 12.76                      |
| 1999 | 17.79                      | 2010 | 12.51                      |
| 2000 | 35.82                      | 2011 | 14.03                      |
| 2001 | 15.42                      | 2012 | 28.47                      |
| 2002 | 25.21                      | 2013 | 14.71                      |
| 2003 | 10.06                      | 2014 | 26.65                      |
| 2004 | 9.78                       | 2015 | 22.59                      |
| 2005 | 12.2                       | 2016 | 16.88                      |
| 2006 | 9.99                       | 2017 | 9.01                       |
| 2007 | 9.42                       | 2018 | 69.66                      |
| 2008 | 14.41                      | 2019 | 15.63                      |

| Jährlichkeit | Pegel Arnabach (GZP 2013) [ $m^3/s$ ] |
|--------------|---------------------------------------|
| HQ30         | 53,7                                  |
| HQ100        | 66,2                                  |
| HQ300        | 78,2                                  |

Massimi annuali di portata registrati ad Arnabach nel periodo dal 1998 al 2019, fonte: Hydrographische Dienst Tirol



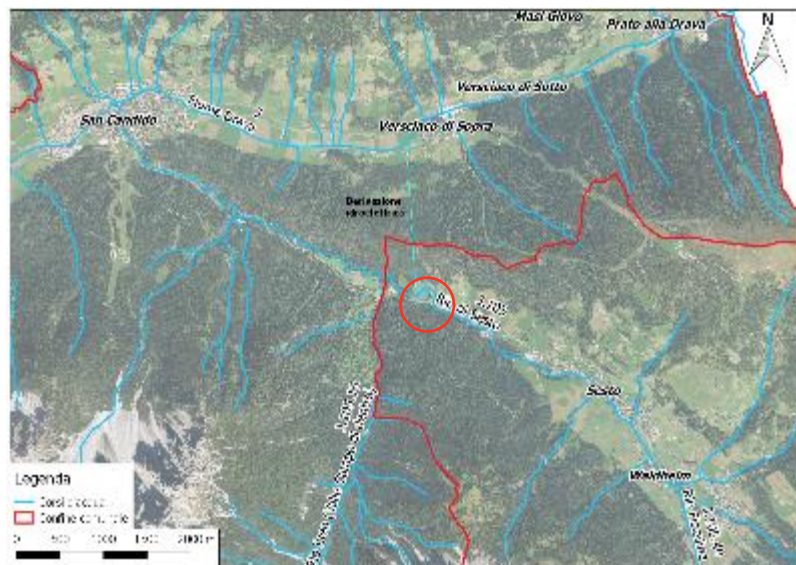
Ereignisdokumentation  
Hochwasser Oktober 2018  
Drau





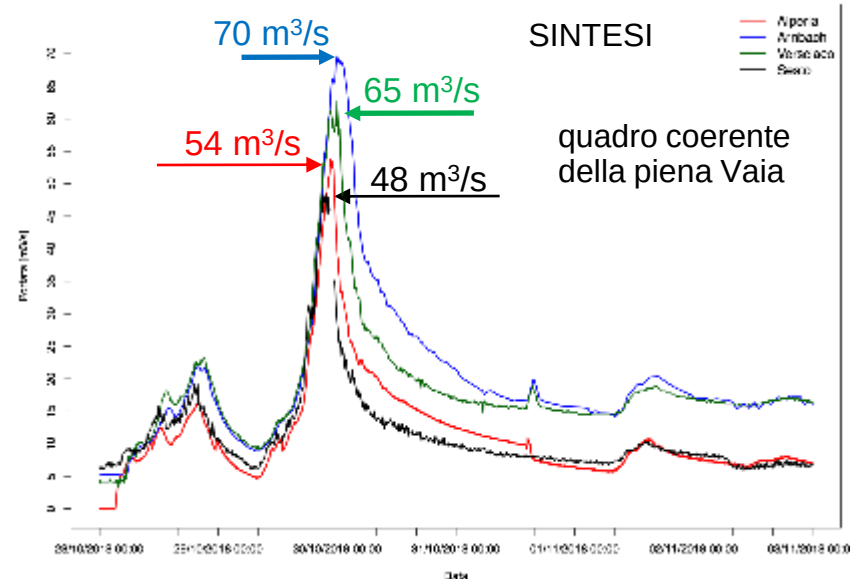
# Dall'analisi idrologica alle forzanti di progetto

Ricostruzione della portata misurata alla Diga di Alperia



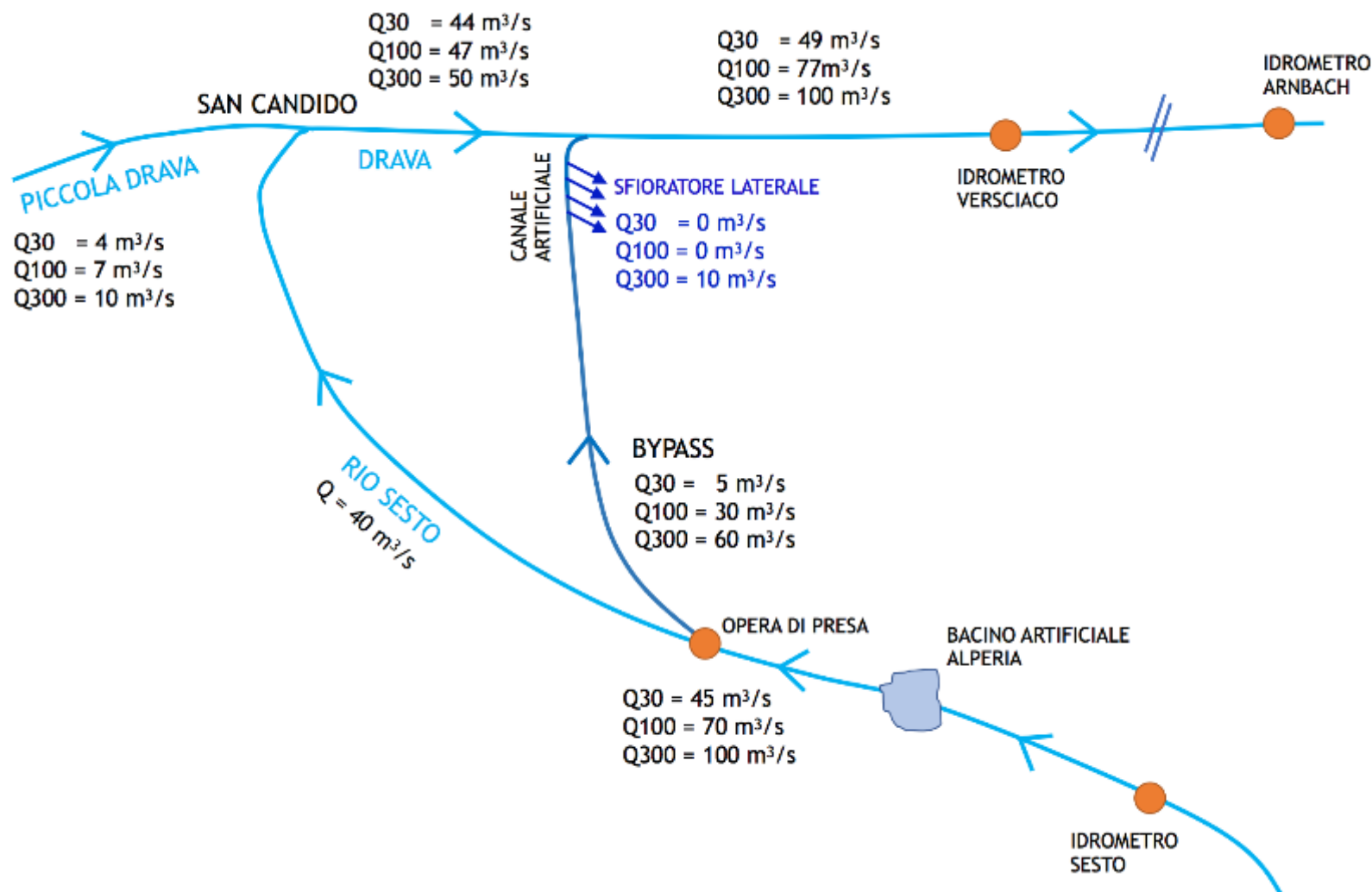
misura di livello ad  
delle 11 bocche di  
sfioro

2 bocche erano  
parzialmente  
ostruite al  
passaggio del picco  
di piena

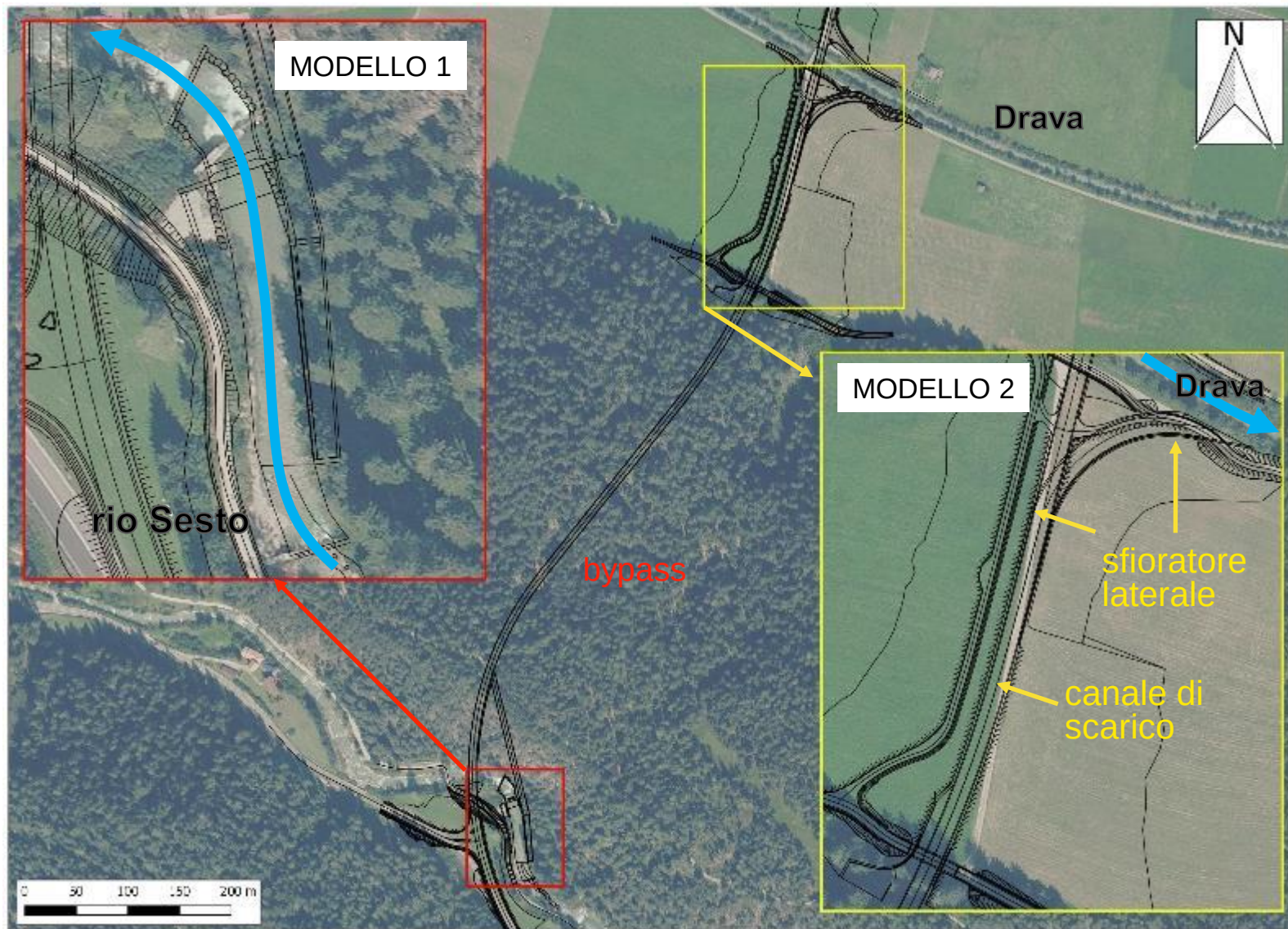


Specialisti Altoatesini per San  
Candido  
Südtiroler Fachgruppe für Innichen

# Lo schema idraulico associato al progetto









# Fenomenologia e trasporto solido

Apporto da monte presente ma limitato (Ixnembach), presenza del bacino di Alperia => valutazioni per gestione materiale solido presso l'opera di presa con modello numerico e fisico => potenziamento di 2 briglie esistenti e costruzione di una nuova di trattenuta

## 1. Analisi dell'evento Vaia

28-30.10.2018

Depositi di materiale durante l'evento Vaia

Rilievi Agenzia di Protezione civile



## 2. Quantificazione del volume di materiale solido di progetto depositabile presso le briglie esistenti

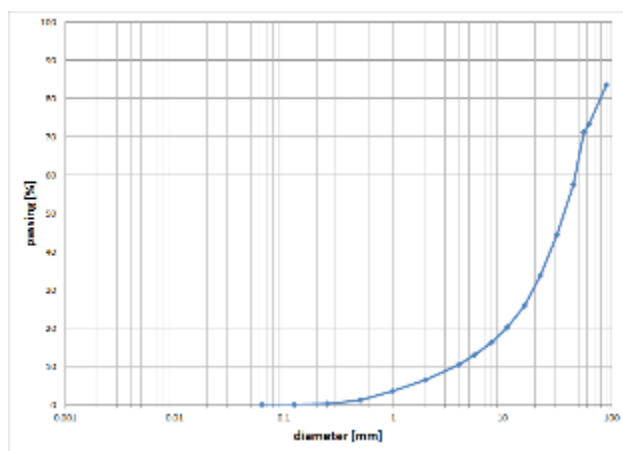
mediante modello numerico e modello fisico



# Fenomenologia e trasporto solido

Taratura del modello numerico sull'evento Vaia e confronto con il modello fisico realizzato dalla Libera Università di Bolzano

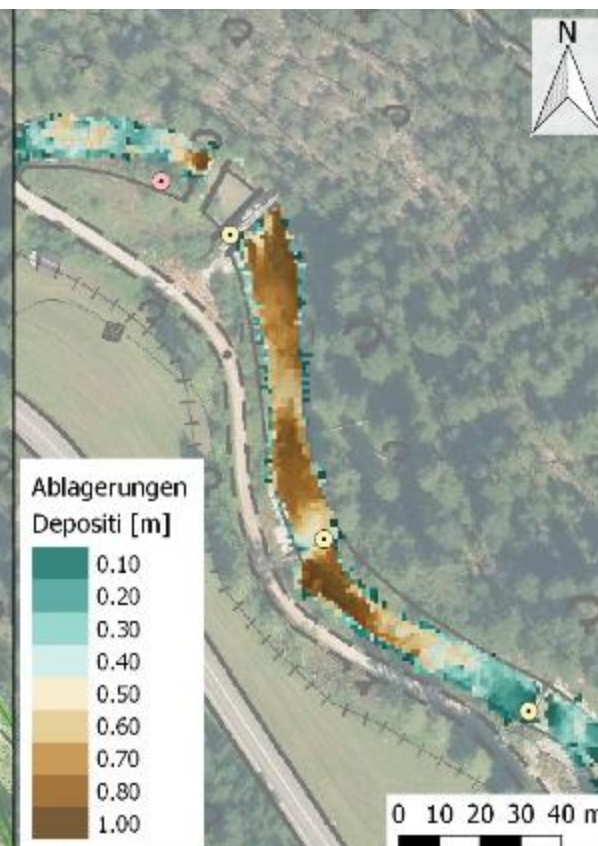
Analisi granulometriche di campioni superficiali e profondi



28-30.10.2018 - Depositi durante Vaia, rilievi Agenzia Pc

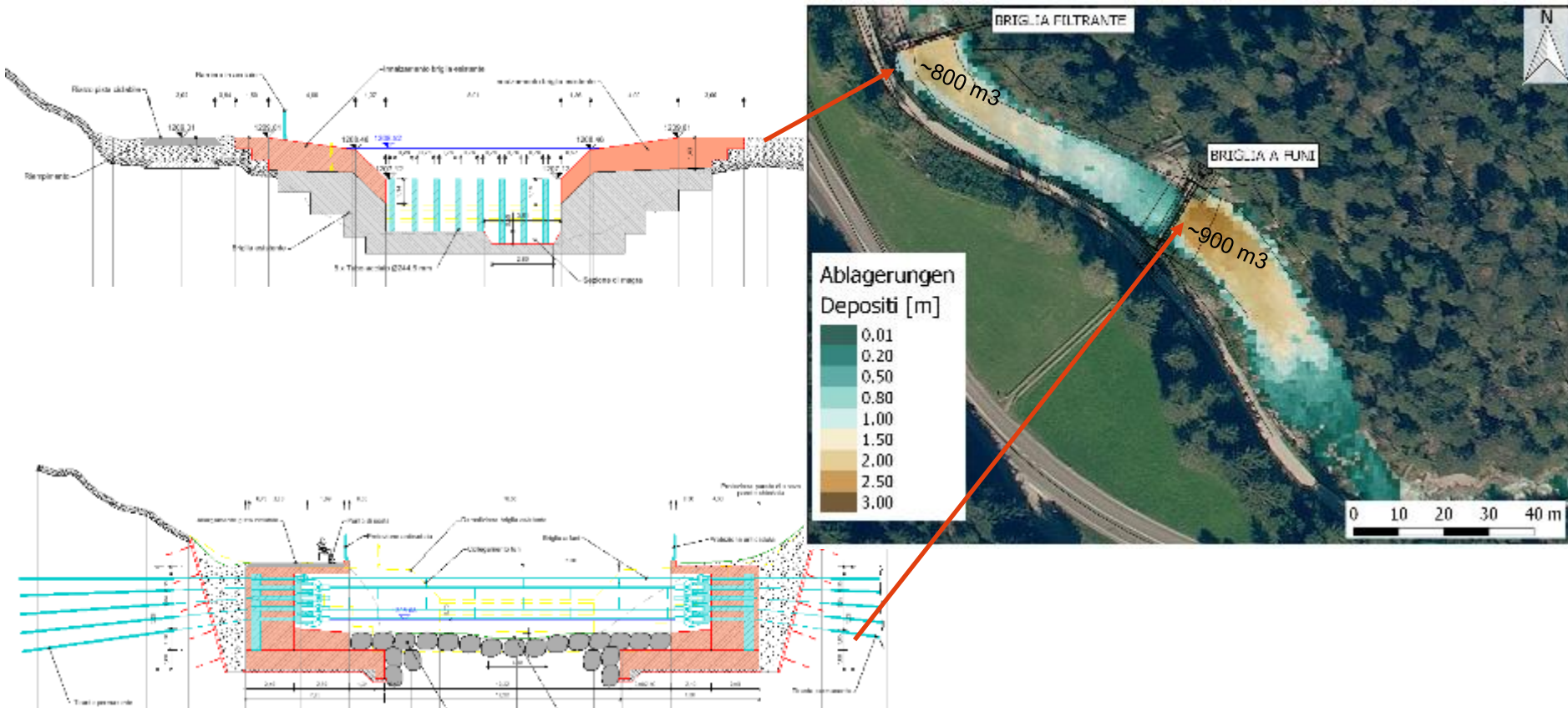


Risultati del modello numerico Basement ETH (Faeh et al., 2012)



# Briglie per la trattenuta del materiale solido e flottante

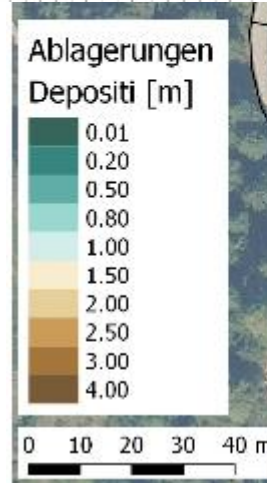
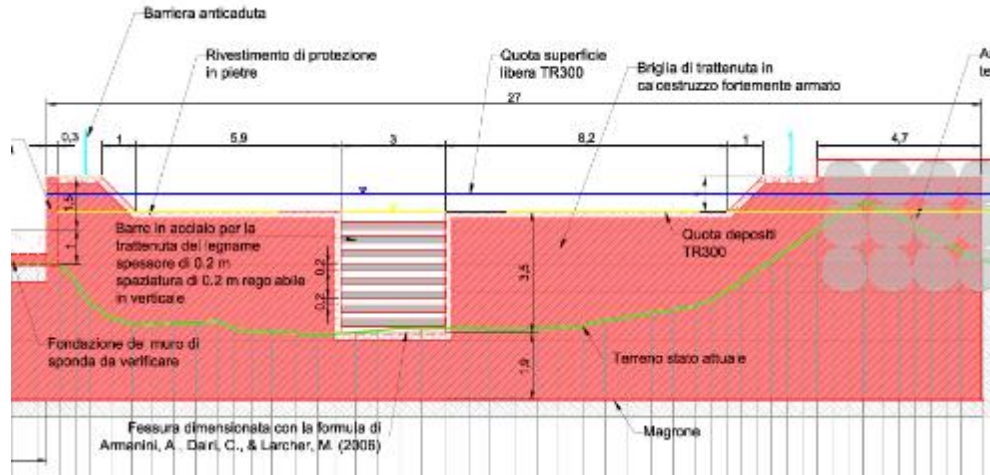
- adattamento e potenziamento delle briglie esistenti;
- dimensionamento idraulico e verifiche mediante modello numerico





# Briglie di trattenuta del materiale solido e flottante

- costruzione di una nuova briglia filtrante a monte della S.S.52

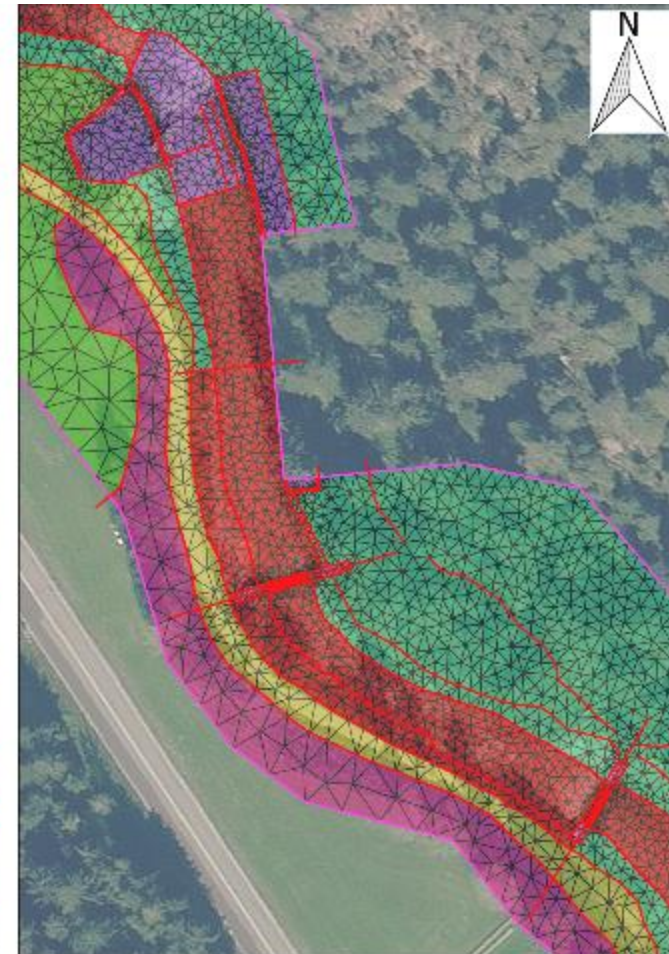
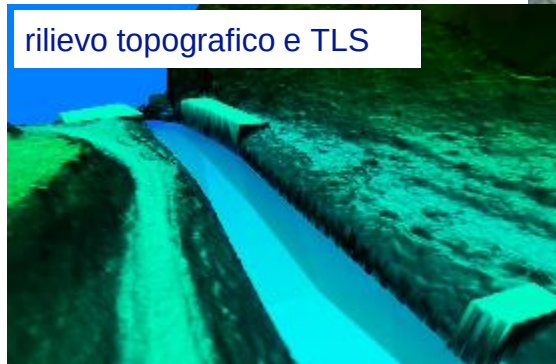






## Opera di presa sul rio di Sesto e adduzione in galleria

- costituita da uno sfioratore laterale con 4 bocche lunghe 10m e una briglia con luce battente
- dimensionamento idraulico mediante modellazione numerica 2D con Basement (ETH) (Faeh *et al.*, 2012) e modello fisico



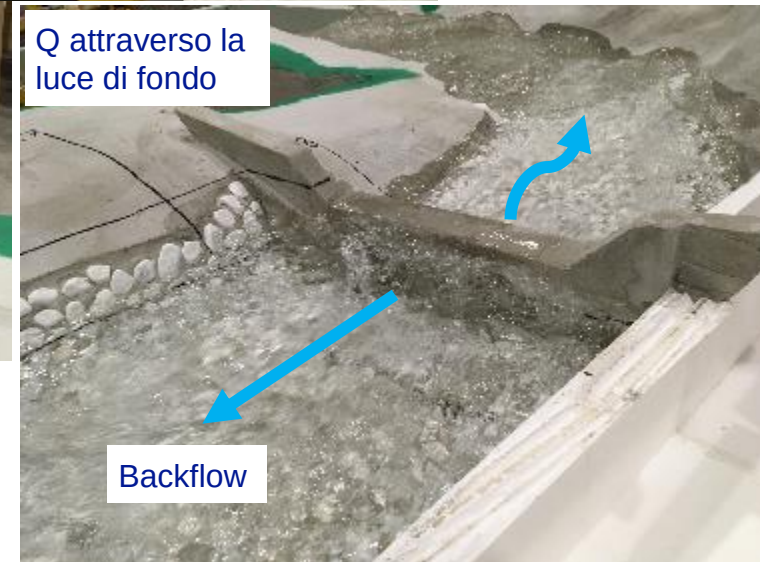
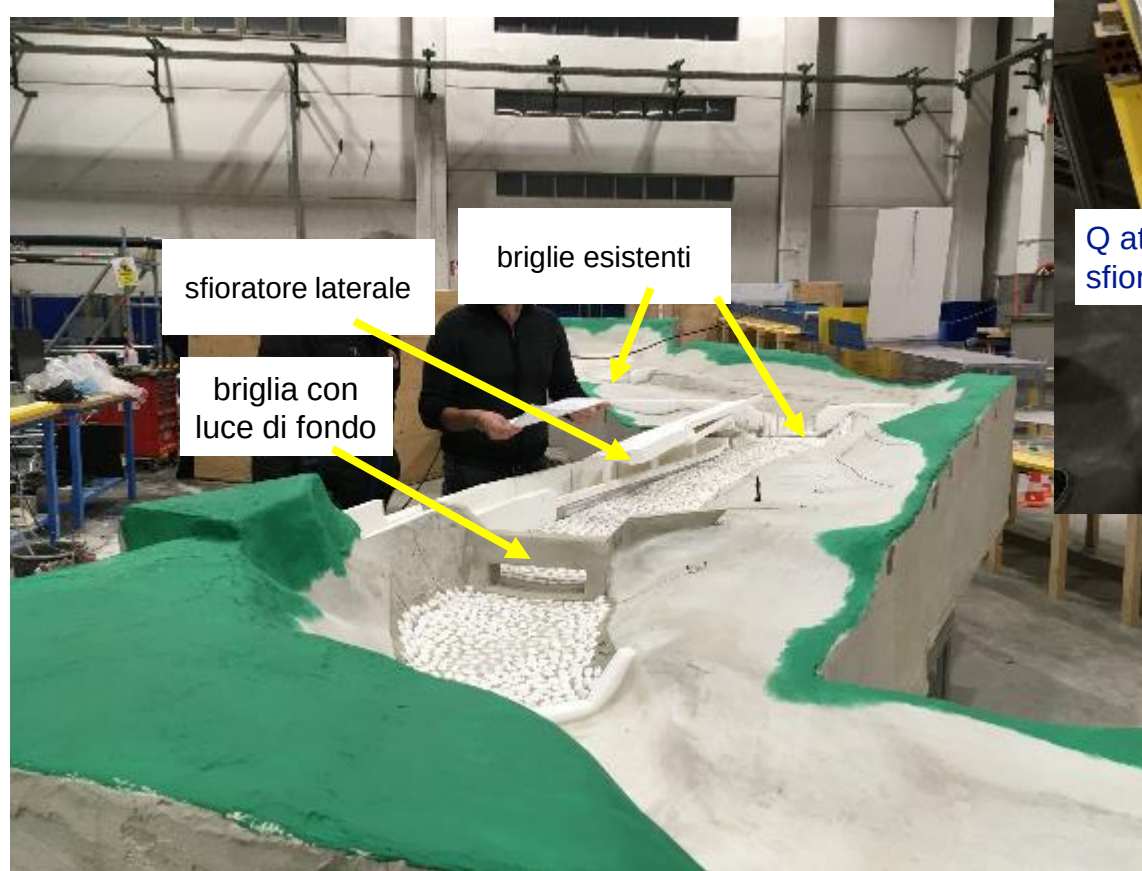
Grass:  $K_s=25 \text{ m}^{1/3}/\text{s}$   
 Riverbed:  $K_s=38 \text{ m}^{1/3}/\text{s}$   
 Banks:  $K_s=38 \text{ m}^{1/3}/\text{s}$   
 Forest:  $K_s=20 \text{ m}^{1/3}/\text{s}$   
 Non-erodible:  $K_s=50 \text{ m}^{1/3}/\text{s}$   
 Cycle path:  $K_s=40 \text{ m}^{1/3}/\text{s}$

**Specialisti Altoatesini per San  
Candido  
Südtiroler Fachgruppe für Innichen**



# Opera di presa sul rio di Sesto

- supporto alla progettazione con modello fisico costruito dalla Libera Università di Bolzano, scala 1:30



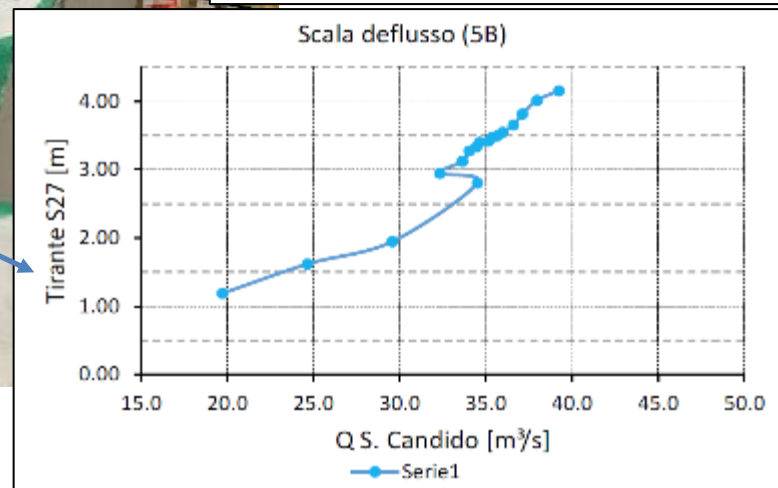
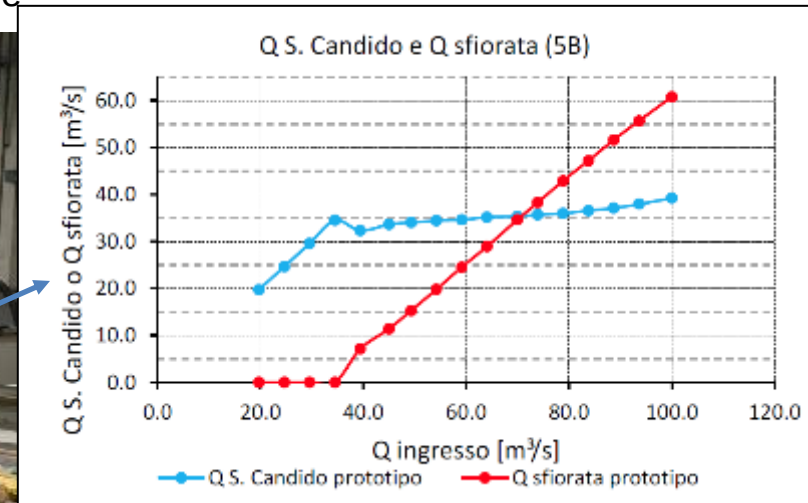
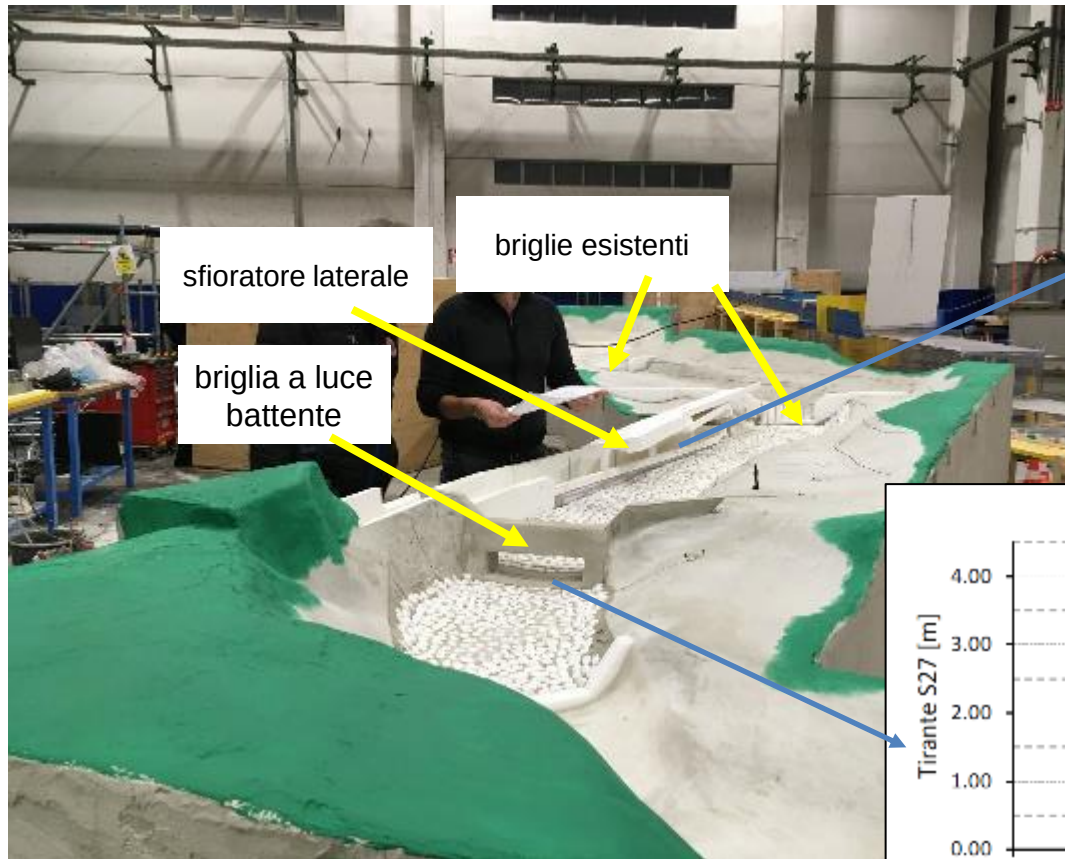
Credits: Free University of Bozen-Bolzano

Specialisti Altoatesini per San  
Candido  
Südtiroler Fachgruppe für Innichen



# Opera di presa sul rio di Sesto

- relazione tra portata effluente dalla luce di fondo e altezza del flusso (scala di deflusso)
- quantificazione della portata smaltita dallo sfioratore laterale



Credits: Free University of Bozen-Bolzano

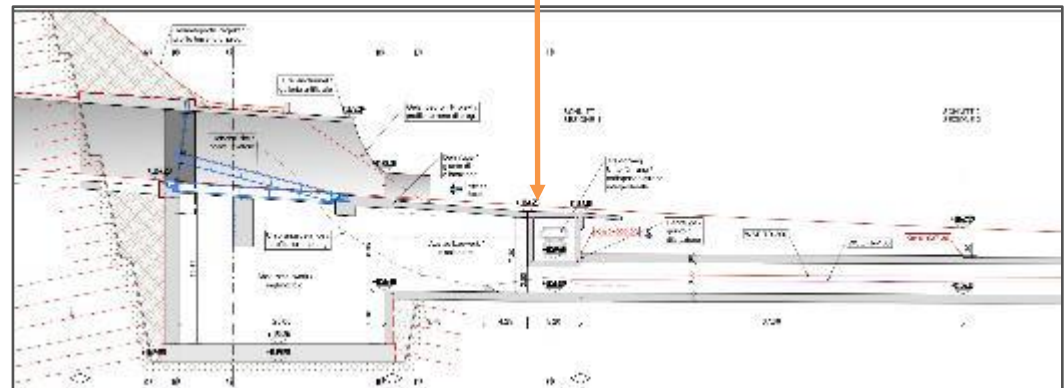
**Specialisti Altoatesini per San  
Candido  
Südtiroler Fachgruppe für Innichen**

# Opera di dissipazione e di scarico in Drava

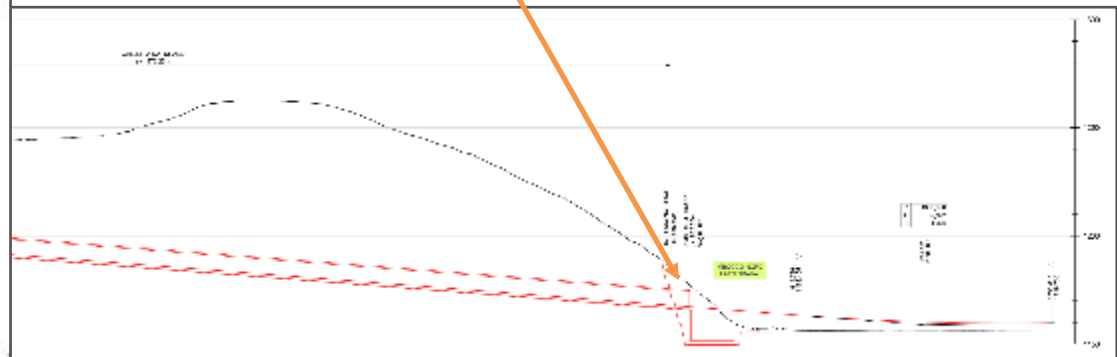
Bypass, dissipatore, canale di scarico,  
sfioratore laterale



attraversamento mezzi agricoli

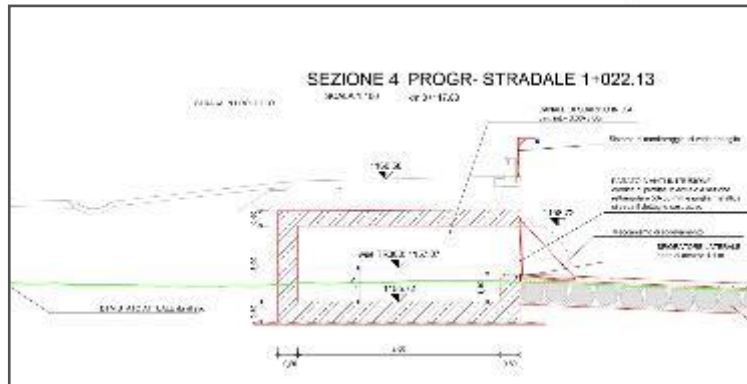
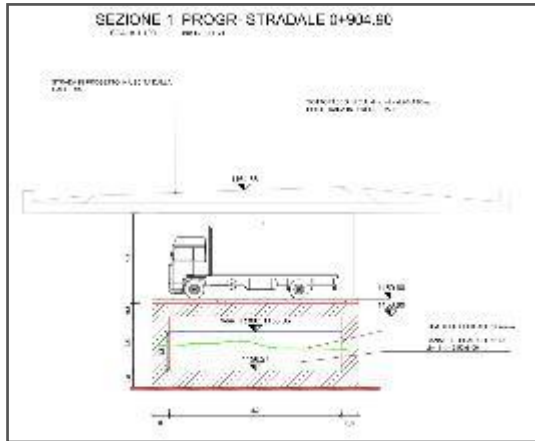


Dissipatore

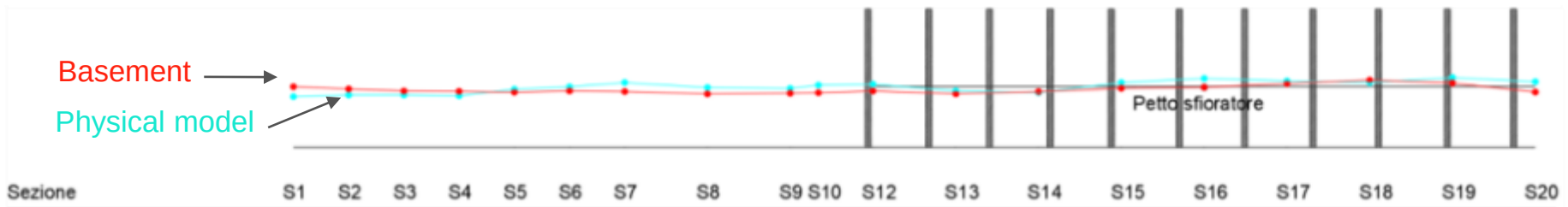




## Verifica idraulica delle opere di scarico

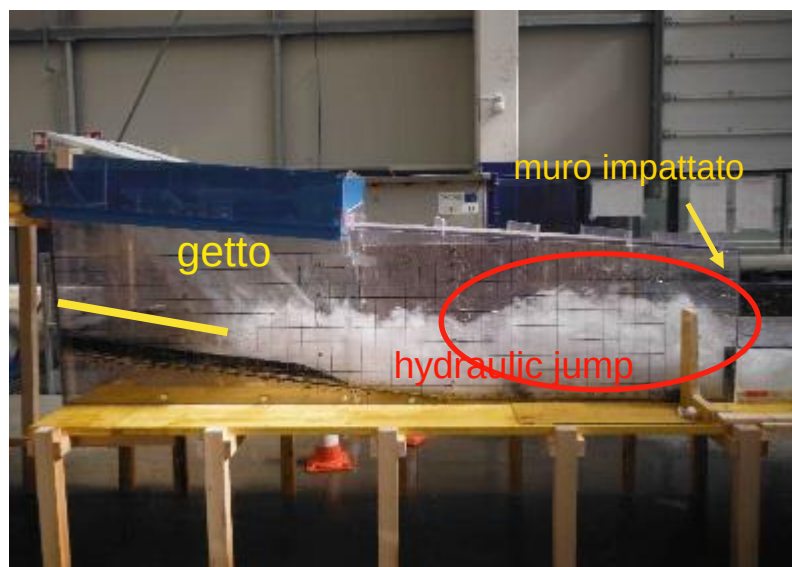
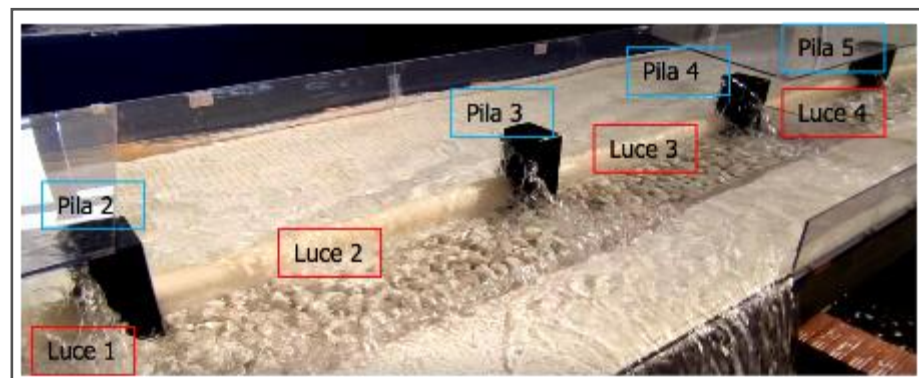


Confronto tra i risultati dei modelli fisico e numerico,  
buon accordo sulla profondità media del flusso ma non  
sulle portate sfiorate



## Dinamiche idrauliche

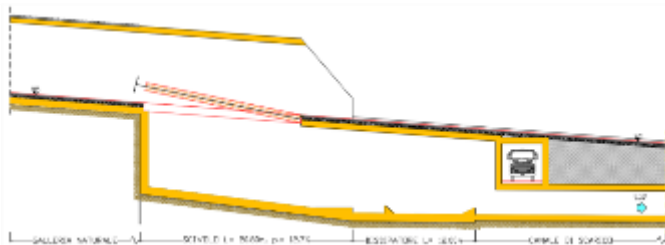
- esistono differenze nelle portate sfiorate tra modelli fisico e numerico; questo è dovuto alle oscillazioni del flusso in uscita dal dissipatore
- la velocità elevata del getto e la sua lunghezza rendono inefficiente la dissipazione (risalto non contenuto);
- il risalto idraulico non contenuto determina un impatto del flusso sull'attraversamento della strada poderale





# Ottimizzazione delle opere in progetto

## progetto iniziale



### GALLERIA A MONTE DELL'INGHIOTTITO

|                           |           |
|---------------------------|-----------|
| $K_s [m^4/3/s]$           | 50        |
| pendenza trasv. fondo [%] | 2,5 - 3,5 |
| pendenza long. fondo [%]  | 7,7       |

### CONDIZIONI IDRODINAMICHE

| TR [anni] | Q [mc/s] | tirante medio [m] | velocità media [m/s] | Froude medio [-] | lvs media [m s.l.m.] |
|-----------|----------|-------------------|----------------------|------------------|----------------------|
| 30        | ---      | ---               | ---                  | ---              | ---                  |
| 100       | 25       | 0,35              | 5,8                  | 3,7              | 1167,87              |
| 300       | 55       | 0,57              | 9,5                  | 4                | 1168,09              |

### GALLERIA A MONTE DELL'INGHIOTTITO

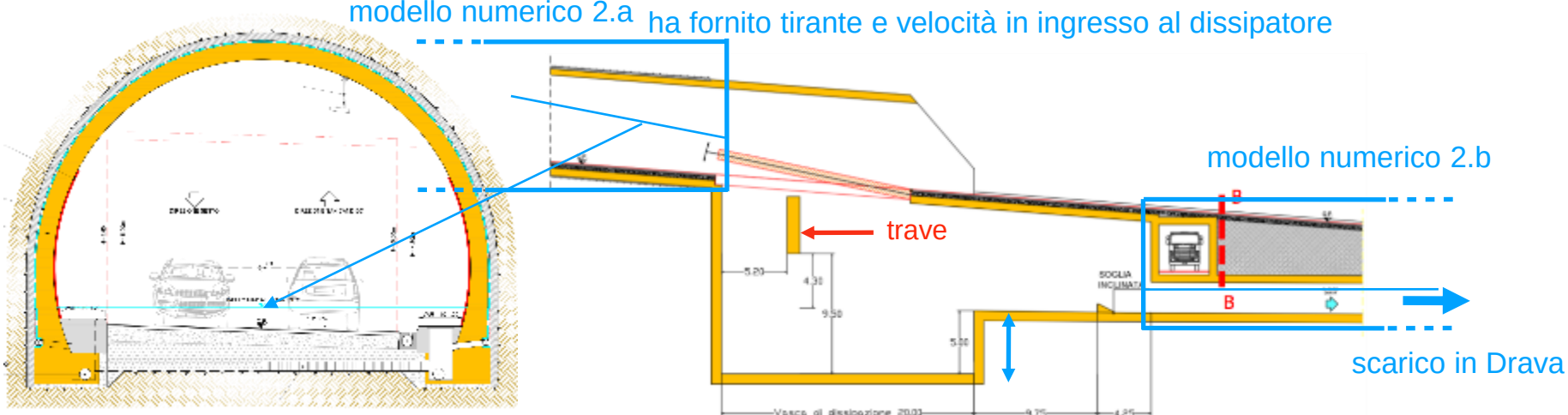
|                           |           |
|---------------------------|-----------|
| $K_s [m^4/3/s]$           | 50        |
| pendenza trasv. fondo [%] | 2,5 - 3,5 |
| pendenza long. fondo [%]  | 7,7       |

### CONDIZIONI IDRODINAMICHE

| TR [anni] | Q [mc/s] | tirante medio [m] | velocità media [m/s] | Froude medio [-] | lvs media [m s.l.m.] |
|-----------|----------|-------------------|----------------------|------------------|----------------------|
| 30        | ---      | ---               | ---                  | ---              | ---                  |
| 100       | 25       | 0,32              | 7,6                  | 4,3              | 1167,78              |
| 300       | 55       | 0,51              | 11                   | 4,8              | 1167,95              |

**progetto ottimizzato** per ridurre le oscillazioni del flusso in uscita dal dissipatore sono state apportate 2 modifiche:  
a) abbassamento del fondo del dissipatore ; b) introduzione di un deflettore per smorzare il getto

modello numerico 2.a ha fornito tirante e velocità in ingresso al dissipatore



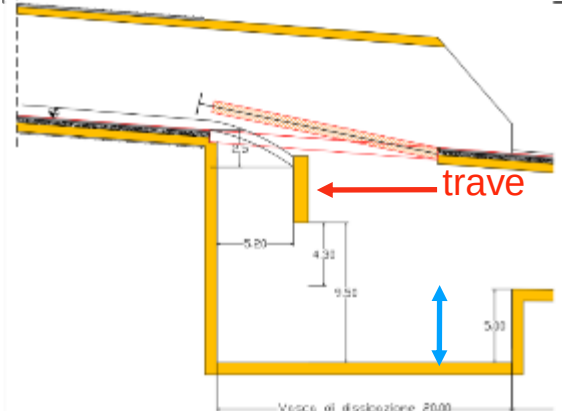
modello numerico 2.b

trave

scarico in Drava

## Le opere ottimizzate

- L'approfondimento del dissipatore ha regolarizzato il flusso in uscita, il moto ha perso buona parte della componente oscillatoria
- la trave ha permesso di smorzare il getto in ingresso al dissipatore, riducendone la velocità
- il risalto idraulico è ora contenuto e il flusso non impatta sull'attraversamento della strada poderale



muro non  
impattato



Grazie per l'attenzione

Domande?



Specialisti Altoatesini per San  
Candido  
Südtiroler Fachgruppe für Innichen