Initial hydrogeological settings of River Neretva Valley

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River Neretva Valley

- Study site in south eastern Adriatic coast;
- App. 4500 ha, 90% cultivated area;
- Used within the WP3, WP4 and WP5;
Before and after.....
What happened during 1960s…
What happened during 1960s…
Site characterization

Initial hydrogeological conditions:

- Hydrogeological characterization has been divided into three cycles;
- Initial cycle is assumed to cover for all available data sets, studies, reports etc.. This stage assumes collection, analysis and interpretation of available documentation;
- This step includes more than 70 different sources, reports and studies ranging from 1962 up to date giving insight to various range of geophysical work (refraction, reflection, geoelectrical probes, boreholes, laboratory results, pumping tests, etc.);
Site characterization

Initial hydrogeological conditions:

- **Second cycle** covers the digitalization of all available documentation within the GIS data base;
- Data base is organised so the user can pick for different search criteria (alphabetical search, chronological search, dana type search);
- More than 500 local data, more than 35 planar dana sets;
Site characterization

Preliminary in situ works

- To distinguish vague data and to optimise general in situ works, a preliminary in situ investigation has been conducted;
- Confirmation of general stratigraphy and lithology;
- Existence of layers and parameter assessment;
- Perform two ERT profiles and eight geoelectrical soundings;
- Results verification with existing borehole data sets.
Site characterization

Preliminary in situ works:

- ERT was performed in the near coast area;
- Four dominant layers identified, sandy partially saturated aquifer, clay layer of 20 m height, gravel layer, variable height ranging from 10 to 15 m, bedrock found inbetween - 37 and – 45 m bmsl;
Site characterization

Verification:

- Borehole cross sections from the area of interest (first and second cycle of initial hydrogeological condition activities);
- ERT and first order data verification by matching stratigraphy;
- Local EC conditions in combination with soil specifications taken into account;
Site characterization

Characteristic cross sections:

- Coastal area shows clear stratigraphy, presence of three geological layers, sandy unconfined layer on top; clay layer, gravel confined layer and bedrock;
Site characterization

Borehole logs:

- In 2015, 125 m deep borehole has been designed;
- Insight to geological settings and layer stratigraphy;
- Confirmation of generated cross sections and initial settings;
Hydrogeological parameters estimation

**Monitoring system:**

- Data sets of observed sea level oscillations and piezometric head time series from different monitoring locations;
Hydrogeological parameters estimation

**Conceptual model application:**
- Selection of appropriate model based on available information, performed analysis and results (geochemistry, geology, etc.);
- Model set up to cover for wide range of parameters (loading efficiency, barometric efficiency, extended roof, outlet capping, hydraulic diffusivity, storativity, hydraulic conductivity);
- Application of tidal methods – the idea relies on hypothesis groundwater fluctuations are induced by tidal fluctuations and aquifers connection to the sea;
- In case of known sea level constituents, piezometric head can be determined as a linear superposition of present constituents;

\[ h(x, t) = ACe^{-apx} \cos(\omega t - aqx - \varphi), \quad x \geq 0 \]
Hydrogeological parameters estimation

Frequency domain analysis:

[Graphs showing hydrogeological parameters over time and frequency]
Hydrogeological parameters estimation

Barometric and loading efficiency estimation:

- D1: BE = 0.14, R = 0.991
- D2: BE = 0.23, R = 0.985
- D4: BE = 0.23, R = 0.997
Hydrogeological parameters estimation

Monte Carlo analysis:

- Model performed for various range of parameters unless minimum RMSE is observed;
- Generated time series of piezometric head;
Conclusions

- Hydraulic diffusivities defined as 430, 1200 and 650 m$^3$/s respectively for DF1, D2 and D4;
- Confined aquifers height defined from geological model;
- Hydraulic conductivity values defined from performed slug tests (10$^{-5}$ – 10$^{-3}$ m/s);
- Storativity values 10$^{-6}$ – 10$^{-4}$;
- Extended roof length L = 1450 m;
- Leakance 0 - 10$^{-4}$ /day;
- Confinement of the deep aquifer confirmed via leakance values and spectral features;
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