Shoreline development in Geneva

Introduction

This study aims to evaluate the hydraulic impact of the lake on the foreseen development projects of shoreline on Geneva lake at its left bank. Currents, waves and sediment transport are studied for three different projects:

- Eaux-Vives beach: 6 alternatives for the shoreline's geometry;
- Geneva beach : 3 alternatives for the beach extension;
- Port Noir: current harbour and 4 expansion alternatives.

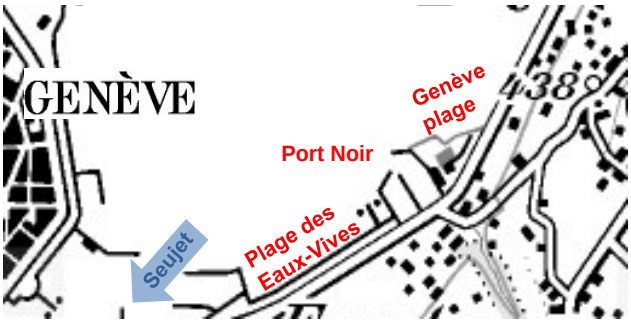

Fig. 1: Project location

Methodology

In order to evaluate the alternatives and to study different hydraulic aspects, numerical simulations are carried out. For this purpose, Mike 21 numerical model (developed by Danish hydraulic Institute, DHI) is applied.

Each geometry is analysed with two conflicting scenarios: weak and strong loading cases. The first scenario is to ensure water quality in the beach zone or in the harbour by quantifying the water residence time, in low loading conditions. The second scenario is to ensure the stability of the beaches by quantifying sediment transport in high loading conditions.

The results are compared to measurements, if they exist (limited to the existing situation). Otherwise, the lack of measurement is compensated by an analysis of sensitivity of the main parameters. Finally, the main results are expressed and quantitated by comparison with the current situation.

Current model

To calculate water quality of the studied alternatives, a current model is used. The first scenario, called "low loading case" is modelled by a minimum flow out of the lake at Seujet and windless conditions. This is the worth condition to assure an acceptable water quality. In such condition, the water renewing time is assessed for different studied alternatives. The alternatives for which a minimum accepted water quality is not achieved are eliminated.

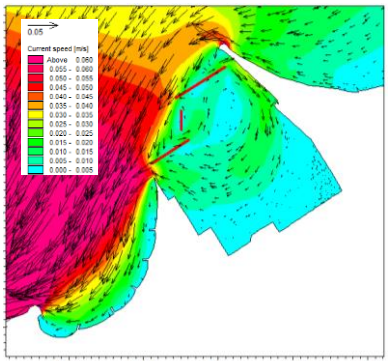

Fig. 2: Velocity field for the curved triangular beach alternative with a discharge of 250 m³/s at Seujet dam.

Wave model

The goal of this model is to define the significant wave height and wave period close to the beach and the currents associated with these waves. The beach is directly subjected to waves induced by the wind from the North – East, Bise. The wave action can erode the beach. This model allows to define the critical diameter of the sand on the beach to withstand the waves.

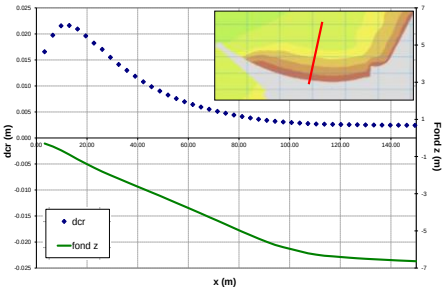

Fig. 3: Critical diameter at the Geneva beach for a 20 years return period event.

Mixing model

To simulate the mixing of the water in the harbour, an analysis is also performed using the advection/dispersion module of Mike 21 software. It aims to quantify the required time to obtain a complete dissolution of a tracer (pollutant) in the beach zone or inside the harbour.

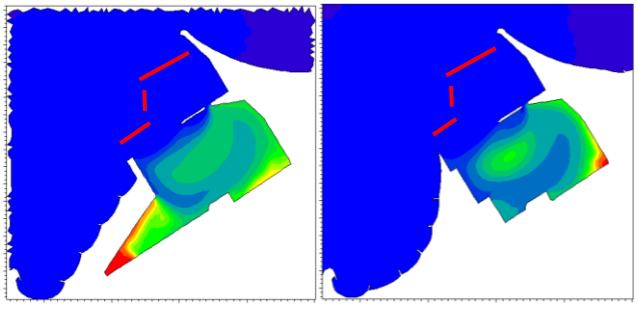

Fig. 4: Water renewal in the harbour after a time 6h and 12h

Conclusion

Taken together, the results indicate that projects of the Eaux-Vive beach, the extension of Geneva beach and expansion of the Port Noir are feasible. The results are used to define the optimal alternative from the water quality and beach stability points of view.

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