UNIVERSITÉ DE NEUCHÂTEL

CHYN
Centre d'hydrogéologie et de géothermie

MSc in Hydrogeology and Geothermics
MSc Thesis Summary, **2017-2018**

Dall'alba Valentin

3D Multiple-point Statistics Simulations of the Roussillon Continental Pliocene Aquifer using DeeSse

This Master project presented the methods and workflows developed in order to model a complex 3D aquifer, using the Multiple-point Statistics (MPS) algorithm DeeSse. The modelled aquifer was the Continental Pliocene layer (PC) that is part of the Roussillon Aquifer in the Perpignan's region, Southern France. This work is part of the Dem'Eaux Roussillon research project that aims to characterize the whole groundwater dynamics of the Roussillon Aquifer in a context of growing population, climate change, and increasing pressure on the freshwater resources in a Mediterranean environment. The purpose of this Master project was to use the direct sampling algorithm DeeSse to model the geology of the PC aquifer. As compared to previous studies using MPS, this is the first time that such a multivariate approach is employed at a regional scale.

MPS algorithms allow to integrate conceptual knowledge of the variables of interest into the simulation with the use of a training image (TI). The TI represents a conceptual model of the variables aimed to be simulated. Due to the complex sedimentation history of the plain, a non-stationary training image (TI) was used during the simulation. The use of such TI requires to create auxiliary maps to constrain the simulations. Hard data, extracted from gamma ray and resistivity log analysis, were used to constrain the simulations. The creation of trend maps and rotation maps were carried out in regard of geological insights gathered from outcrops and knowledge of the aquifer. I developed new procedures for auxiliary variables creation and used multiple-variables simulations in order to create a complex 3D model of the PC aquifer.

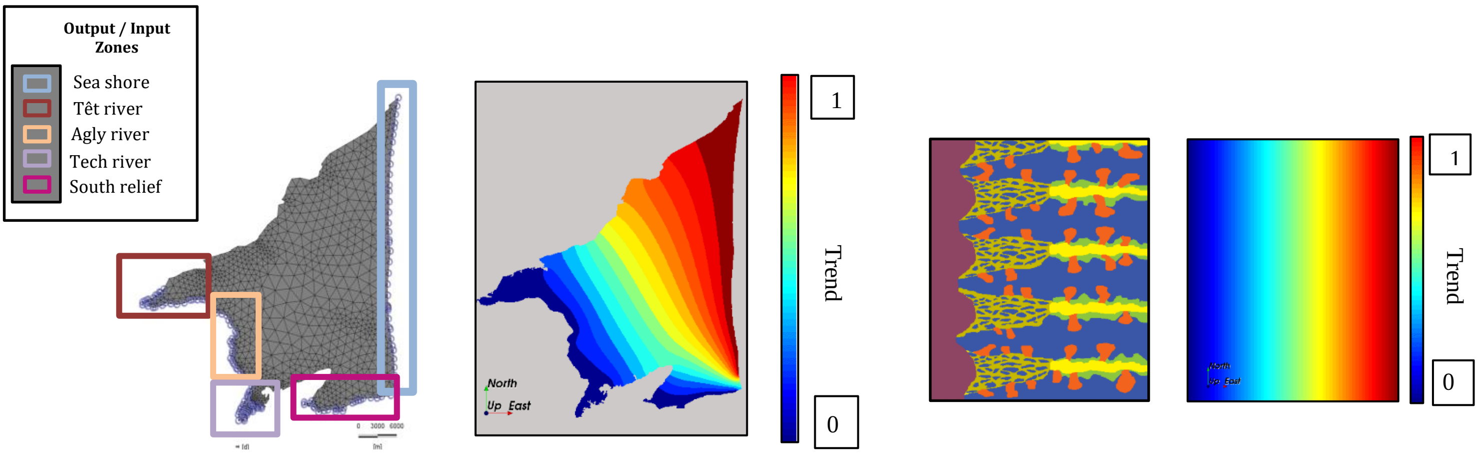

Figure 1: The different elements that compose the MPS model. From left to right: the 2D simulation grid in FEFLOW, the 2D trend map for the grid, the 2D TI, the 2D trend map for the TI.

The final model was analyzed by performing different sets of 100 simulations in order to calculate facies probability maps. A Shannon entropy map was also calculated from the probability maps, the calculation of the Shannon entropy allowed us to define zones of high uncertainties in our model. Finally, I demonstrated that the hydraulic conductivity of the different sedimentary deposits cannot be represented by unique values. Based on transmissivity estimation, we conclude that the hydrological characteristics of the deposits were heterogeneous over the PC aquifer. This work was innovative due to the utilization of multiple-variables for the simulations and continuous rotation map.

New methods to validate the model have still to be defined and created for MPS simulation. Cross-validation or vertical connectivity matrix could be used to test the model. We had determined from post-simulation calculations that the meander system was not perfectly define in the TI. Further investigations need to be carry out in order to understand the shape of the meander bed and their lateral connectivity. Such information could be gathered from geophysical methods. Finally, the hydraulic connectivity of the different facies are likely to be heterogenous over the plain, a new approach needs to be defined to calculate these parameters and to test it against our model.

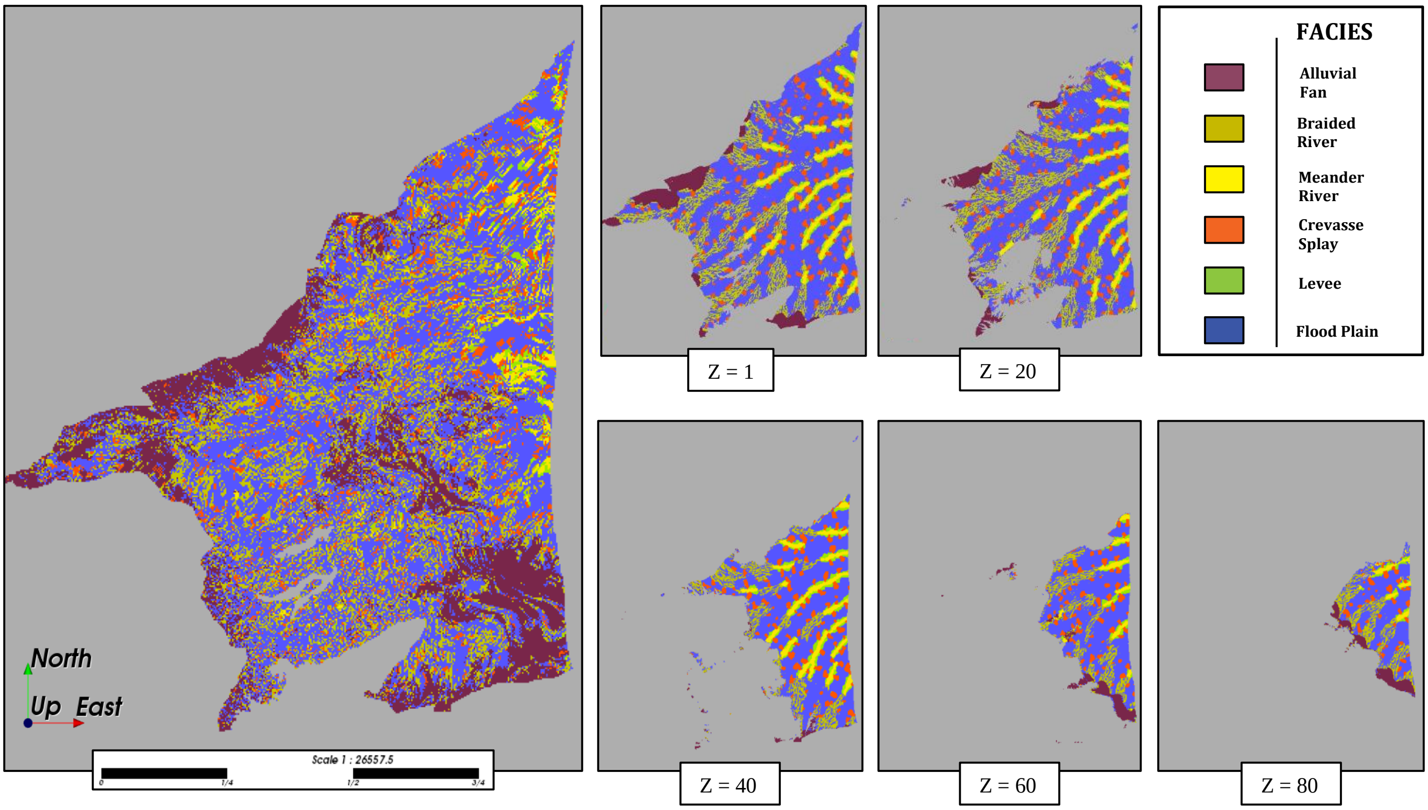

Figure 2 : The final MPS simulation. The left figure corresponds to a top view of the 3D model. The five small figures correspond to different 2D layers that compose the 3D model. 6 facies were simulated based on the TI and on the trend maps.