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Application of Data Mining Models in Prediction of Wave-induced Scour Depth around Piles

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Various arrangements of pile groups are widely being used as supports of marine structures. As piles are located on erodible beds of the sea, scouring is a threat to such structures and the scour depth around pile groups should be considered well in their designs. The arrangement of the piles in addition to their geometry, sediment and wave characteristics should be considered to estimate the scour depth around a group of vertical piles. Regarding the importance of prediction of scour depth, several empirical formulae have been presented to predict equilibrium scour depth around piles, but such approaches which are mostly based on dimensional analysis and data correlation of laboratory tests do not always produce reasonable results for field conditions or even for laboratory cases.

Considering the complexity of modeling the scour process and scour hole properties around pile groups due to waves, the existing approaches are not capable of accurate estimation of the scour depth around pile groups with different arrangements. Hence, a robust model is very useful for the estimation of scour depth.

One of the most common approaches as an alternative to empirical approaches is the soft computing method. Artificial neural networks (ANN) as a famous data-mining method have been widely applied in scour estimation (e.g. Liriano & Day 2001; Kambekar & Deo 2003; Bateni & Jeng 2007; Zounemat-Kermani et al. 2009; Kazeminezhad et al. 2010).

Support Vector Machines (SVM) as another data mining approach were also successfully applied in wind speed prediction (Mohandes, et.al, 2004), run-off modelling (Bray & Han, 2004), prediction of storm surge (Rjasekaran et al. 2008), hourly reservoir inflow forecasting (Lin et al. 2009), effective forecasting of hourly typhoon rainfall (Lin et al. 2009) and prediction of significant wave height (Mahjoobi & Mosabbeb 2009).

In current study, two data mining approaches, i.e. Support Vector Machines (SVM) and Artificial Neural Networks (ANN), were applied to estimate the wave induced scour depth around pile groups. To consider various arrangements of pile groups in the development of the models, datasets collected in the field and laboratory studies were used and arrangement parameters were considered in the models. Several non-dimensional controlling parameters, including the Keulegan–Carpenter number, pile Reynolds number, Shield's parameter, sediment number, gap to diameter ratio and numbers of piles were used as the inputs. Performances of the developed SVM and ANN models were compared with those of existing empirical methods.

Results indicate that the data mining approaches used outperform empirical methods in terms of accuracy. They also indicate that SVM will provide a better estimation of scour depth than ANN (Artificial Neural Network).