Evaluation de l'impact du changement climatique sur la ressource en eau du système karstique du Lez au moyen d'un modèle global semi-distribué

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karst for both the simulation of spring discharge at outlets and the analysis of the hydrodynamics of the compartments considered in the model. This platform is generic in the sense that its aim is to propose a modular model structure adaptable to each specific site. It was realized within the framework of the KARST observatory network initiative from the INSU/CNRS, which consists in organizing research at the national scale to bring out issues and scientific advances in karst, specifically in terms of links between physical processes and both hydrodynamics and hydrochemistry. The modular property allows to reproduce most mathematical reservoir models structures of the literature. In order to avoid time-consuming calibration, a monte carlo procedure is included in the platform, allowing the automatic adjustment of the parameters. The platform also provides various graphical outputs. Thanks to its friendly interface, no programming skills are required to run the modeling platform. KARSTMOD will prove especially useful for teaching and occasional users.

9.4.8 (o) Linear and Nonlinear System Engineering techniques applied to the Fuenmayor Karst Spring, Huesca (Spain)

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Fuenmayor is a modest karst spring that tapes a small limestone aquifer near Huesca, Spain. A monitor station built on 2002 on the spring have provided an hourly dataset of rainfall, discharge, water electrical conductivity and temperature and air temperature. By the use of System Engineering black box techniques, a linear transfer function between effective rainfall and discharge has been concluding that Fuenmayor has an acceptable linear response of 0.8164, evaluated by the Nash ?Sutcliffe model efficiency coefficient However, the linear model does not estimate adequately the response to some events where the non-linearities are evidenced. To deal with the nonlinear characteristics of Fuenmayor, it is proposed a black box model based on the Hammerstein-Wiener block-oriented structure. It is composed by a linear dynamic system surrounded by two static nonlinearities at its input and output. Seven different configurations of blocks are studied. A good result is obtained with a configuration where the linear block is a second order transfer function, with a zero and seven unit delays. The first nonlinear block is a piecewise polynomial and the second block has been suppressed. The running test draws out a maximum Nash-Sutcliffe efficiency of E=0.9383, a value better than the linear response.

9.4.9 (o) Evaluation de l'impact du changement climatique sur la ressource en eau du système karstique du Lez au moyen d'un modèle global semi-distribué

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Dans cette étude, l'impact du changement climatique sur la ressource en eau du système karstique du Lez pompé pour l'AEP de l'Agglomération de Montpellier a été évalué à l'aide d'un modèle hydrogéologique global semi-distribué. Une modélisation inverse a été menée au moyen de fonctions de transfert de façon à prendre en compte l'existence de plusieurs compartiments hydrogéologiques et la sollicitation du système karstique par les pompages. 9 scénarios climatiques issus de modèles climatiques forcés avec le scénario d'émission ń A1B ż, et désagrégées par la méthode « type de temps » du CERFACS ont été utilisés. Les scénarios climatiques choisis couvrent deux périodes temporelles, l'une pour le présent (1971-2000) et l'autre pour le futur (2045-2065). Ces scénarios projettent une augmentation de la température moyenne mensuelle comprise entre +1,5˚C et +2,3˚C (±1˚C) suivant la période de l'année (moyenne multi-modèle). Pour la pluie, une tendance à la diminution des cumuls pourrait se dessiner de l'ordre de 10 % à l'échelle annuelle. La recharge par la pluie efficace calculée par le modèle hydrogéologique pourrait fortement diminuer dans le futur, pour atteindre -30% du cumul annuel moyen de pluie efficace. La diminution de la recharge se traduirait par une augmentation de la durée des assecs de la source du Lez ainsi que par une diminution du débit moyen de débordement de la source, en période de hautes eaux. Lors des périodes estivales (assecs), les niveaux piézométriques seraient plus fréquemment situés sous les niveaux actuels. Toutefois, en maintenant le taux de pompage actuel, le niveau piézométrique retrouverait chaque année le niveau de débordement de la source (à 65 m NGF).

9.4.10 (o) Water exchanges between a saturated karstic conduit and its surrounding rock : Evidences from isotopes in water and groundwater flow modeling

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The exchanges of water between the conduits and its surrounding rock in a karstic aquifer are key parameters to understand the changes of water quality at the outlet of these aquifers. The mechanisms controlling these exchanges under saturated conditions are explored using a 2D coupled continuum-conduit flow model (Feflow®). The flows in the conduits and in the surrounding rock are described by the Manning-Strickler equation and the Darcy law respectively. We choose fluid transfer conditions to describe the conduit boundaries, which imply that the hydraulic heads at the boundaries of the conduit are not fixed. Thus the model can calculate freely the amounts of water exchanged between the two domains.
Isotopic (18dO and 2H), discharge and water head measurements were conducted on the Val d'Orléans karstic aquifer (France), during the 2008 hydrologic cycle in aim to estimate at the outlet, the amount of water exchanged between the conduit and the surrounding rock and to confronted the observations with the numerical results.
The results show a spatial variability of the water exchanges from recharge to discharge areas that are controlled by the turbulent head loss in the conduit and by the boundary conditions. The confrontation with isotopic mixing calculation suggests that the point recharge in the conduit is the key factor to describe these exchanges. The amounts of exchanged water are significant only for rock hydraulic conductivities up to 10-5 m/s and if the recharge flow rate in the conduit is inferior to the maximum discharge capacity of the conduit. Point recharge flow rates control the observed transient changes of water exchanges between the two domains. The transient calculations evidence a zone where the water is mixed by the following flood, at the interface between the conduit and the rock.