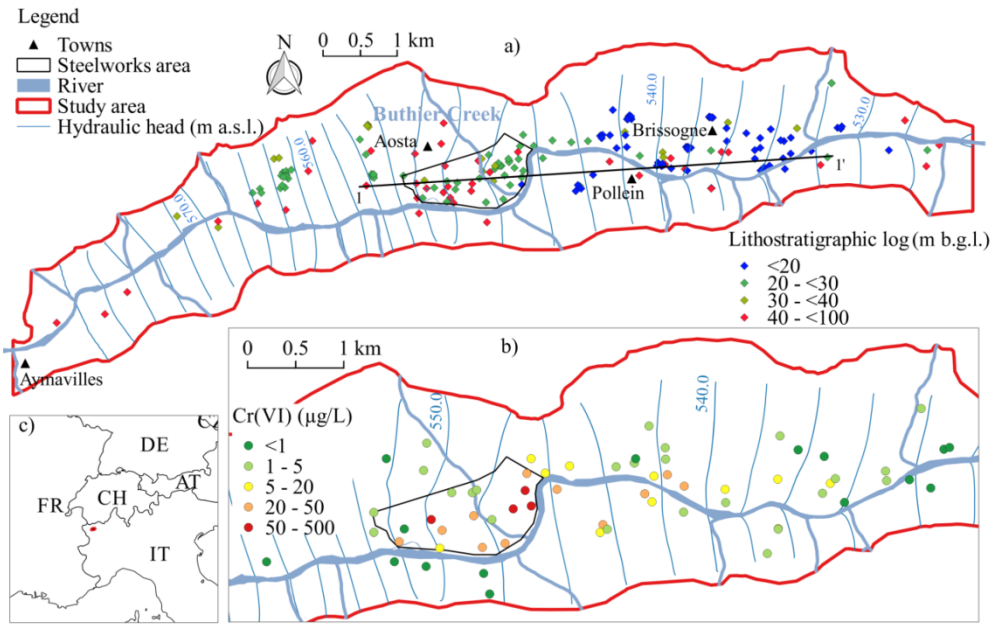
	3 月
文獻來源	Gennaro A. Stefania, Marco Rotiroti, Letizia Fumagalli, Chiara Zanotti and Tullia Bonomi , (2018), Numerical Modeling of Remediation Scenarios of a Groundwater Cr(VI) Plume in an Alpine Valley Aquife , *Geosciences 2018, 8(6), 209, 1-15.*
英文	This work presents the numerical modeling of remediation scenarios aimed at containing and attenuating the groundwater pollution by Cr(VI) sourced from a steelworks area that affects the Alpine aquifer system in the Aosta Plain (N Italy). Here, groundwater is used for drinking water supply and food and beverage production, so the adoption of remediation works is urgently needed. More specifically, three remediation scenarios were modeled using MODFLOW-2000 and MT3DMS: (a) the activation of a hydraulic barrier to contain the pollution within the source area (Scenario 1); (b) the removal of the pollution sources and the natural attenuation of the residual groundwater plume (Scenario 2); and (c) a combination of the previous two works (Scenario 3). Model results for Scenario 1 showed that a hydraulic barrier composed of five wells located along the eastern border of the steelworks area would contain Cr(VI) concentrations above 5 µg/L (i.e., the Italian regulatory limit) within the steelworks area; the barrier would have a total discharge of 27,500 m3/day, which could be compensated by the deactivation of three steelworks wells; the hydraulic barrier would drop the Cr(VI) concentrations below 5 µg/L in the areas downstream of the steelworks after ~3 years from its start of operation. Results for Scenario 2 highlighted that the removal of the Cr(VI) sources would drop the Cr(VI) concentrations below 5 µg/L in the areas downstream of the steelworks after ~2.5 years, and lead to a full remediation of the Cr(VI) groundwater plume (i.e., total Cr(VI) mass in the aquifer close to zero) after 17 years. Results for Scenario 3 showed that the removal of the Cr(VI) sources accompanied by the activation of the hydraulic barrier would led to a faster remediation within the first 14 years from the starting of the remediation works, with concentrations below 5 µg/L in the areas downstream of the steelworks obtained after ~2.3 years.
中文	本研究是利用數值模式預先模擬整治方案的效果，以了解各方案的優缺點以進一步評估何種方案較為適合。污染的來源是位在義大利的奧斯塔平原上的一家鋼鐵廠區，產生 Cr(VI)污染了地下水源。該污染場址的 Cr(VI)的濃度超過 5µg/ L，不符合義大利法規的檢測上限濃度值(5µg/ L)。然而在這個平原的地下含水層是屬於阿爾卑斯含水層，主要提供民生飲用水及食品與飲料的用水來源，因此迫切需要採取整治措施以恢復地下水質。

針對此案例，作者提出三種整治方案，第一種是以多個抽水井建立起水力屏障以控制污染源的擴散。第二種方式是直接以挖除的方式將污染源清除，並且讓殘留在地下水的污染藉由移流以自然衰減的方式恢復到原來的水質品質。第三種方法就是將第一種與第二種方法結合使用。數值模式是採用 MODFLOW-2000 和 MT3DMS 來模擬三種整治方案，第一種方案的模擬情境結果顯示，在鋼鐵廠區東部邊界建立五口抽水井組成水力屏障的方式，以每天 27,500 立方米的總排放量執行整治，而這個抽水量藉由停掉鋼鐵廠所使用的三個抽水井來彌補，以避免造成地下含水層過度抽取造成地層下陷等可能的問題發生。在開始執行整治約 3 年後，如此的整治方式使煉鋼廠下游區域的 Cr(VI)濃度降至 5μg/ L 以下。第二種方案的結果則是強調挖除 Cr(VI)污染源土方約 2 年半後，鋼鐵廠下游區域的 Cr(VI)濃度降至 5μg/ L 以下，歷經 17 年地下水移流作用使含水層的水質完全修復(即含水層中的總 Cr(VI)質量接近於零)。第三種方案的結果表示，挖除 Cr(VI)污染源並在邊界設置抽水井抽水，從開始進行整治約 2、3 年時間，在鋼鐵廠下游區域的 Cr(VI)濃度就低於 5μg/ L，整個整治時間約莫花費 14 年即恢復水質原本情況，相較其他整治方法，更為快速。