

# **Sustainable use and protection of groundwater resources in delta areas: the fresh maker and fresh keeper**

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In coastal areas, fresh groundwater resources are limited and when exploited they are often subject to intrusion of brackish and saline groundwaters. Two technological remedies against these problems are presented: the fresh maker and the fresh keeper. These concepts make it possible to preserve and even enlarge fresh groundwater reserves, allowing sustainable groundwater abstraction. Interception of brackish water is key to these concepts and, when treated with reverse osmosis (RO), this water forms an additional fresh water source.

Salinization of water wells can be prevented by simultaneously abstracting upper fresh water and lower brackish groundwater, preventing upconing of brackish groundwater into the fresh water layer. This so-called fresh keeper concept was successfully applied at well field Noardburgum, the Netherlands (Vitens Water Company). The abstracted brackish water is treated with RO and used as an additional water source, and so the once abandoned well now produces more fresh water than the original volume.

The fresh maker protects thin fresh groundwater lenses by interception of underlying brackish water using horizontal abstraction wells or drains. Combination with artificial recharge during the wet season will even increase the fresh water storage, thereby enlarging the amount of fresh water available for crop irrigation in the growing season. The use of horizontal wells or drains makes the technique applicable in thin aquifers. A field scale pilot of the fresh maker is planned in autumn 2012.