

## IAH network on “Coastal aquifer dynamics and coastal zone management”

### QUESTIONNAIRE

IAH national committees, IAH members and non members from all around the world involved in SWI and SGD research and management are kindly asked to fill in the

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|-----|---|---|
| 1)  | Location of aquifer (country, more specific location):  | Magdalen Islands (Iles-de-la-Madeleine, Quebec, Canada), archipelago composed of the following inhabited islands: Cap-aux-Meules, Havre-aux-Maison, Ile-du-Havre-Aubert, Pointe-aux-Loups, Grosse-Ile, Ile-de-Grande-Entree   |
| 2)  | Reported by:  | Jean-Christophe Comte and Olivier Banton  |
| 3)  | Type of medium (karst, porous, fracture)  | Porous  |
| 4)  | Type of aquifer (phreatic or confined)  | Phreatic  |
| 5)  | Main lithology - (e.g. gravel, sand and clay)   | poorly consolidated Permian sandstones (aquifer) overlying carboniferous (mostly impervious) rocks  |
| 6)  | Hydrochemistry: fresh or saline   | Fresh to saline (freshwater lens)   |
| 7)  | Saltwater intrusion: lateral from sea or lakes - upconing   | Upconing below pumping wells  |
| 8)  | Aquifer geometry: hydraulic characteristics   | Aquifer transmissivity of $4 \cdot 10^{-3} \text{ m}^2/\text{s}$ .  |
| 9)  | Aquifer parameters: storage - annual water pumping - (in MCMA - millions cubic meters, annually)  | Surface model recharge (mm/y) 230<br>Subsurface entering lateral flows (L/s) 30<br>Combined pumping rates (L/s) 16 to 55 depending on the period  |
| 10) | Depth of aquifer (water level and bottom) - water level 5- 30 m - aquifer depth - 50-200 m  | 0 to few 100s of m  |
| 11) | Major chemistry (anions - ?; Cations - ?):  | Na Cl   |
| 12) | Major salinity sources:   | Seawater and possibly evaporites in salt diapir areas   |
| 13) | Population:   | ~13 000 inhabitants   |
| 14) | Aquifer status: special features - e.g. thermal springs, major faults,...   |   |
| 15) | Investigation methods - e.g. water level measurements, EC (electrical conductivity profiles), TDEM (geophysical),                                       | Groundwater well monitoring (heads and EC)<br>Electrical resistivity tomography (ERT) to image the geometry of the saltwater wedge and saltwater upconing   |
| 16) | Numerical hydrological modeling, chemical and isotopic methods, age determination, IR survey, seepage meters (for Submarine Groundwater Discharge, SGD) | 3-D variable-density flow hydrogeological model. Goelectrical forward/inverse modelling.  |
| 17) | Monitoring methods applied and duration - water level measurements, EC (electrical conductivity profiles - seasonal)                                    | Permanent telemetric monitoring in municipal wells (heads and EC)<br>Temporary monitoring in relation to specific hydrogeological studies (eg. Madelin'Eau, 2004)   |
| 18) | Management methods:   | Telemetric monitoring system operated by the Municipality. Optimal distribution of borehole abstraction based numerical modelling studies   |
| 19) | Aquifer management actions:   | Decrease of abstraction below boreholes showing (i) saline contamination (ii) upconing formation (iii) risk of long term upconing from groundwater modelling  |
| 20) | Identification of existing or potential problems:   | Because of increasing consumption, total dependency on coastal groundwater and the inappropriate distribution of both the population and the water wells (through the islands generates an unequal pressure of water withdrawals), the Magdalen Islands (Quebec, Canada) are a typical example of seawater intrusion problem from upconing  |
| 21) | Annexes:  | <p>Madelin'Eau, 2004 – Gestion des eaux souterraines aux Îles-de-la-Madeleine, Un défi de développement durable, Rapport final déc. 2004.</p> <p>J.C. Comte and O. Banton, 2006. Modelling of Seawater Intrusion in the Magdalen Islands (Québec, Canada). Proceedings of the 19th Salt Water Intrusion Meeting, Cagliari, Italy, pp 303-310. <a href="http://www.swim-site.nl/pdf/swim19/pages_303_310.pdf">http://www.swim-site.nl/pdf/swim19/pages_303_310.pdf</a></p> <p>Comte, J.C. and Banton, O., 2007. Cross-validation of geo-electrical and hydrogeological models to evaluate seawater intrusion in coastal aquifers. Geophysical research letters, 34(10).</p> <p>Lemieux, J.M., Hassaoui, J., Molson, J., Therrien, R., Therrien, P., Chouteau, M. and Ouellet, M., 2015. Simulating the impact of climate change on the groundwater resources of the Magdalen Islands, Québec, Canada. Journal of Hydrology: Regional Studies, 3, pp.400-423.</p> |
| 22) | Observations:   | Due to poorly consolidated nature of the aquifer sandstone, there is an important risk of coastal erosion with resulting shrinking of the freshwater lens   |