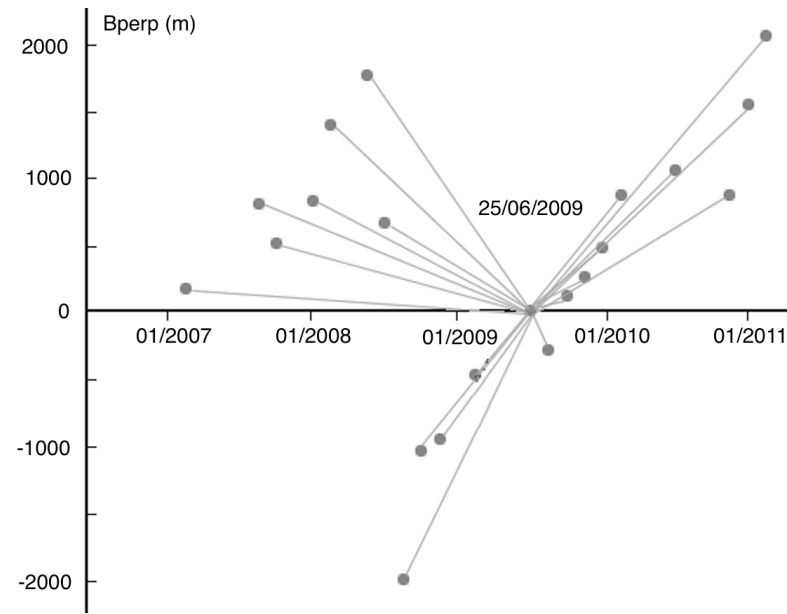
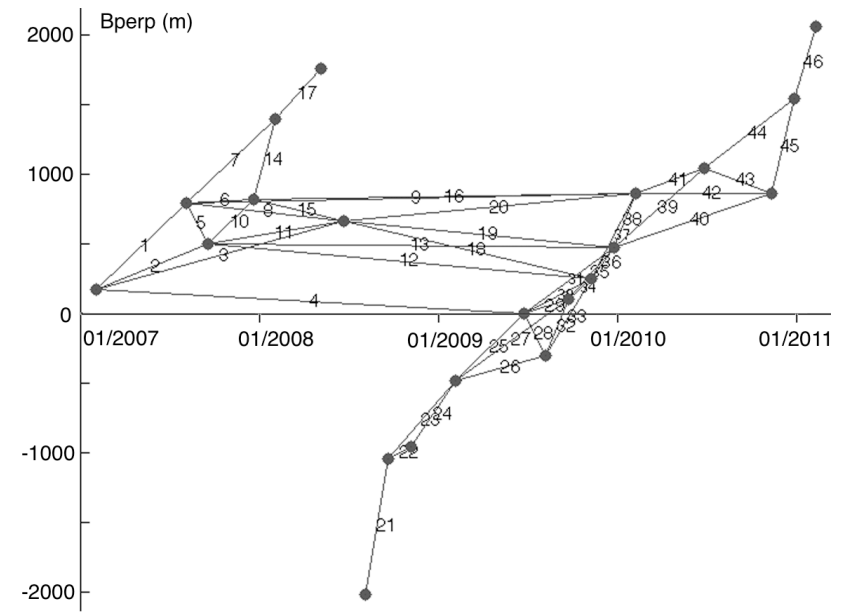


**Fig. 1:** Map of Hanoi City urban region, with location of urban and suburban districts (after NARENCA, 2009). The black box corresponds to the area under study with the InSAR approach in Fig. 3.

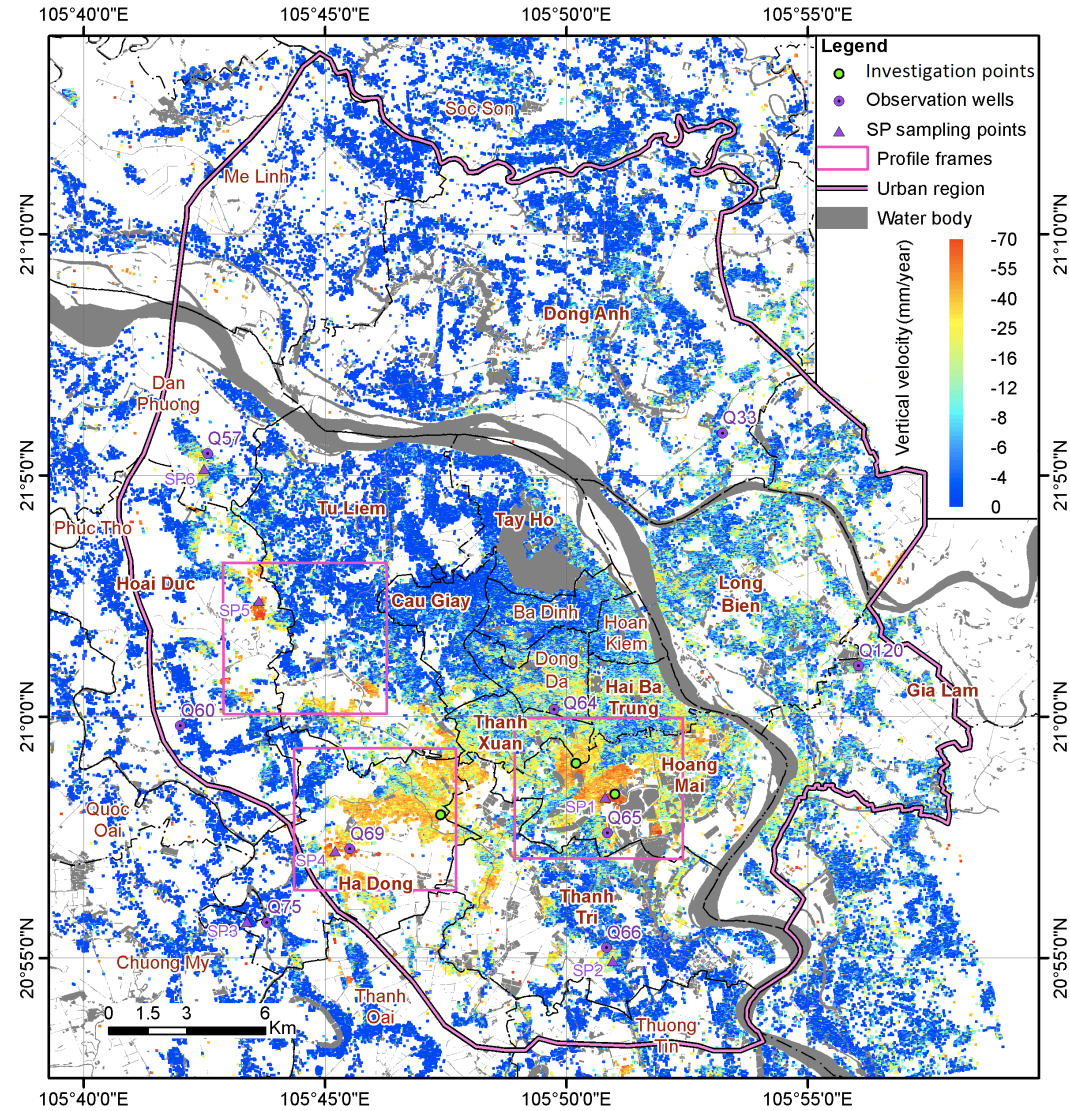


(a)



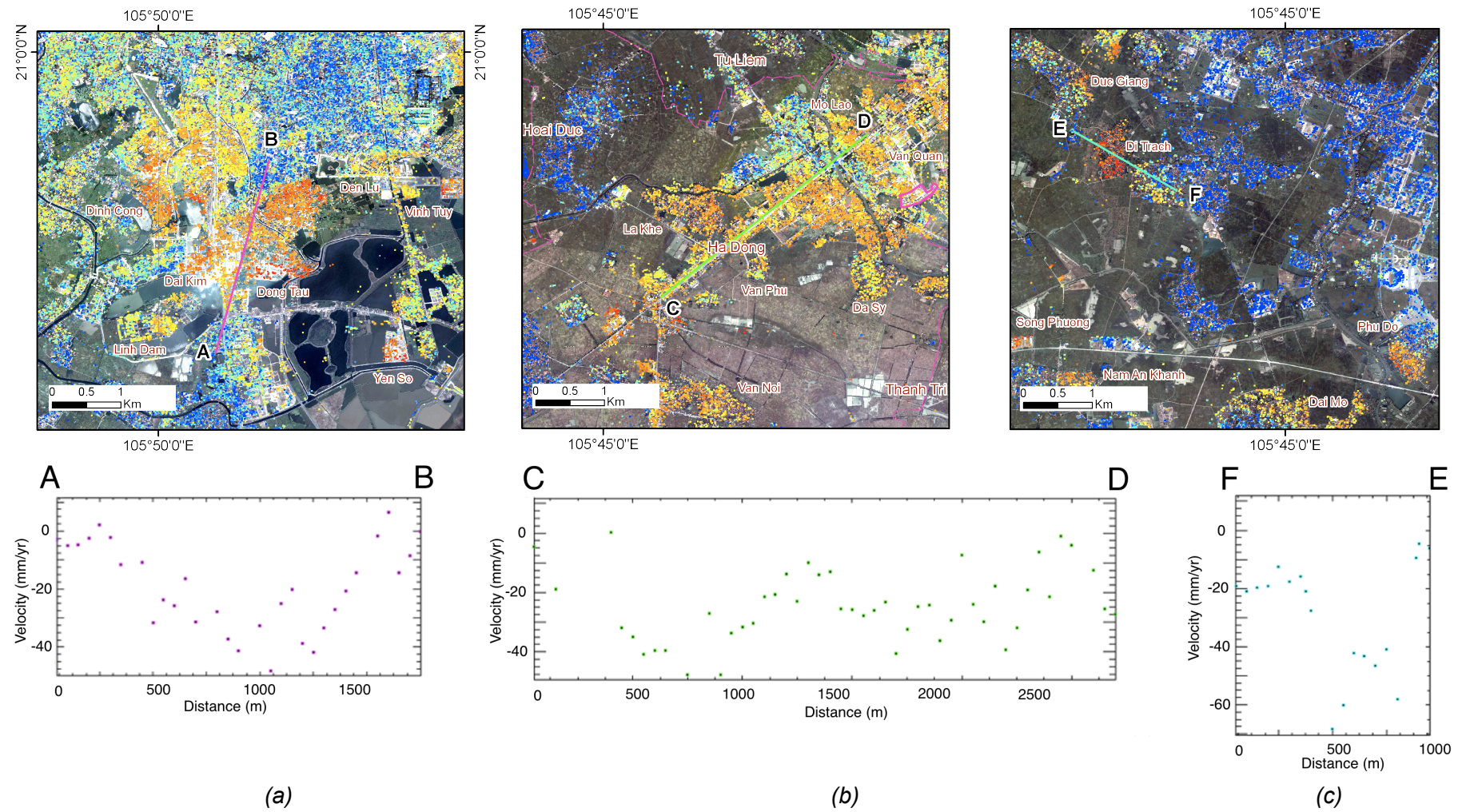
(b)

**Fig. 2:** Baseline plots for **(a)** the PS approach and **(b)** the SB approach. Perpendicular baseline (Bperp) is calculated with respect to the master image (date: 25 June 2009) used in the PS approach.



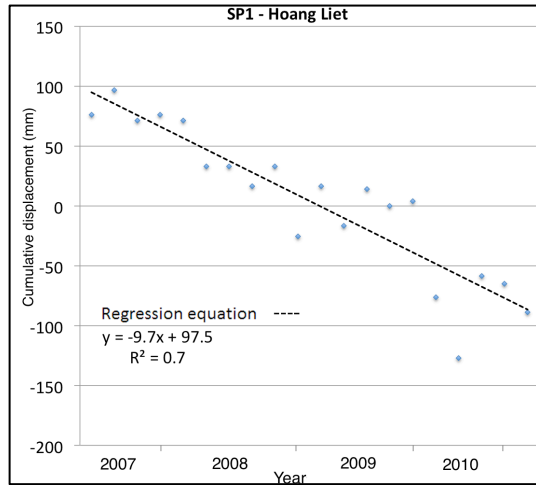
**Fig. 3:** Averaged vertical subsidence velocity in urban region of Hanoi (location in Fig. 1) issued from InSAR processing for the period February 2007 – February 2011. Red boxes are the locations for the Fig. 4a-c.



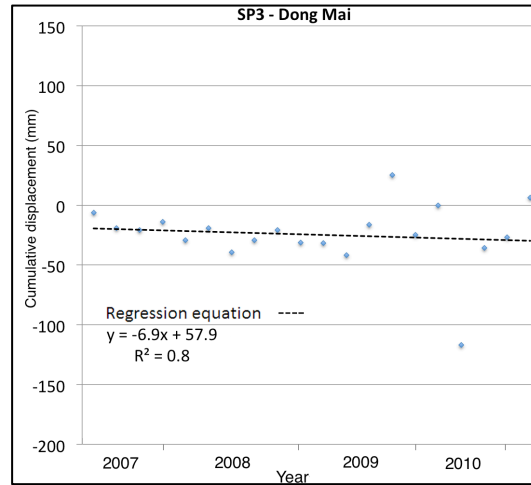


**Fig. 4:** Close-up maps and vertical velocity profile at (a) the Hoang Mai subsidence area (b) the Ha Dong subsidence area (Magenta boundary presents monitoring subsidence by leveling at Van Quan residential zone) (c) the Hoai Duc subsidence area. For location of frame and color scale, refer to Fig. 3.

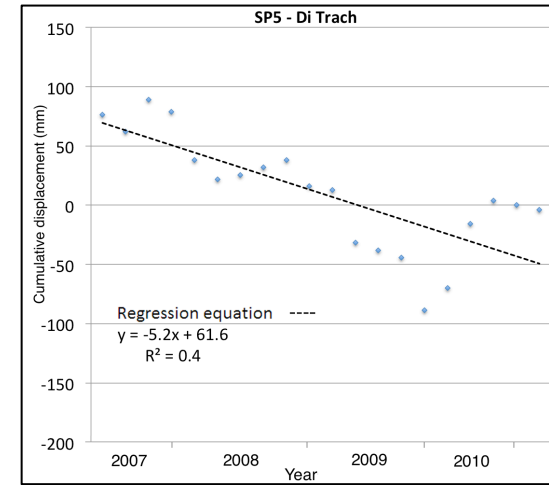




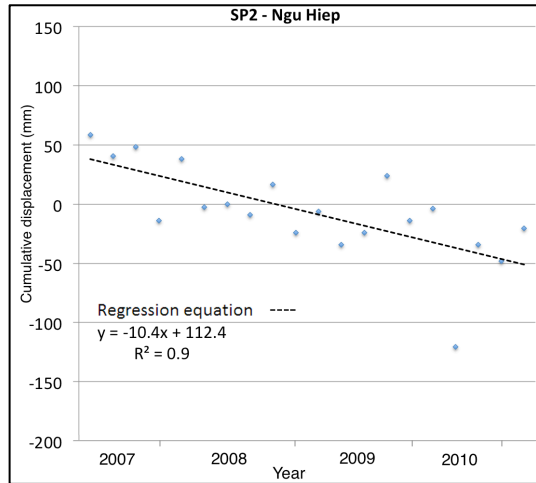
(a)



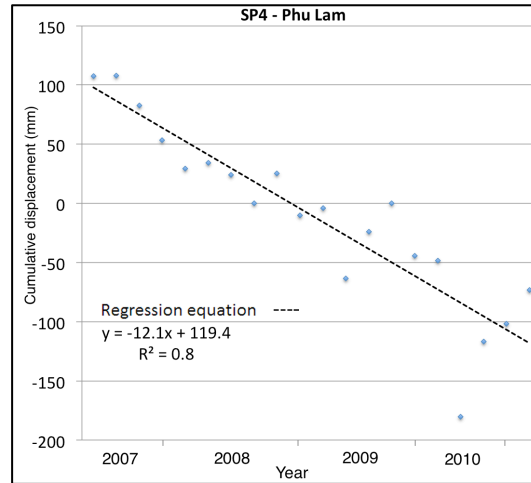
(c)



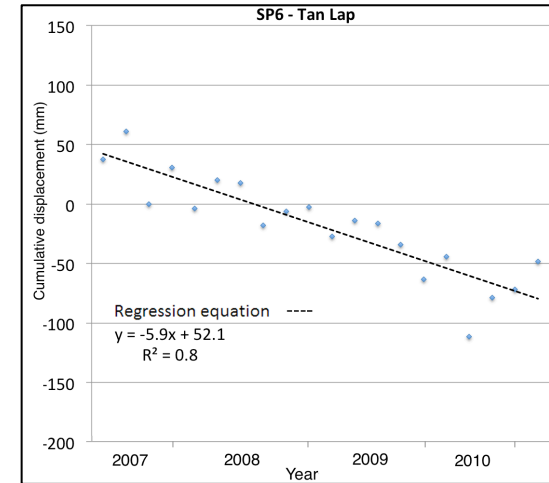
(e)



(b)

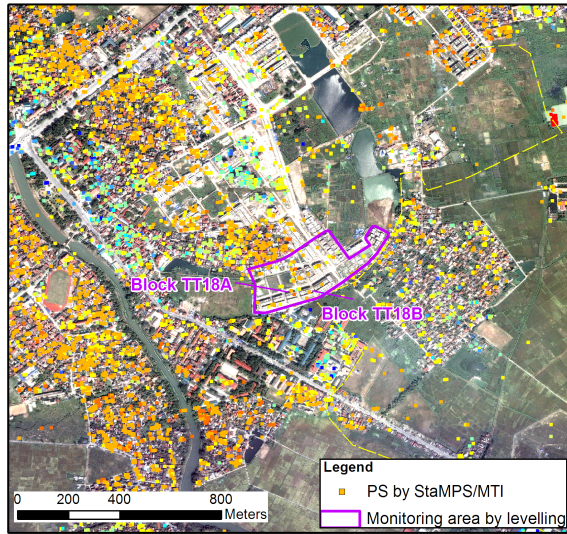


(d)



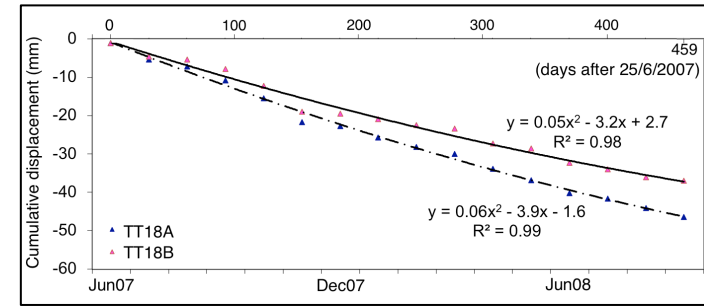
(f)

**Fig. 5:** Time series of vertical displacement at several **SP** pixels at (a) Hoang Liet, Hoang Mai, (b) Ngu Hiep, Thanh Tri, (c) Dong Mai, Ha Dong (d) Phu Lam, Ha Dong, (e) Di Trach, Hoai Duc, (f) Tan Lap, Hoai Duc. For location of **SP** sampling points, refer to Fig. 4.

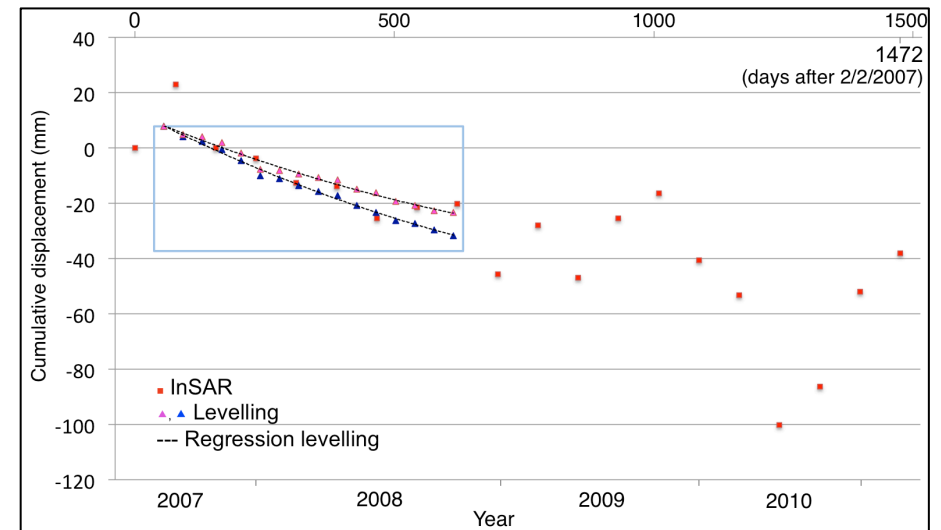


(a)

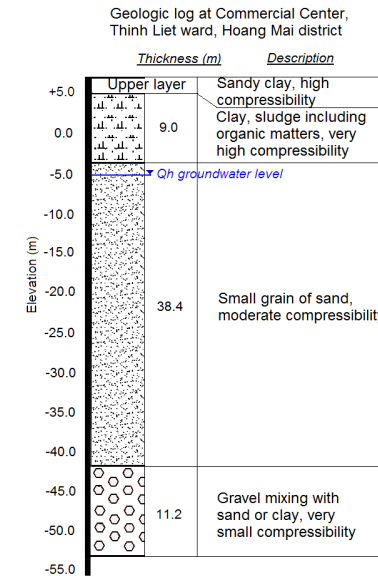
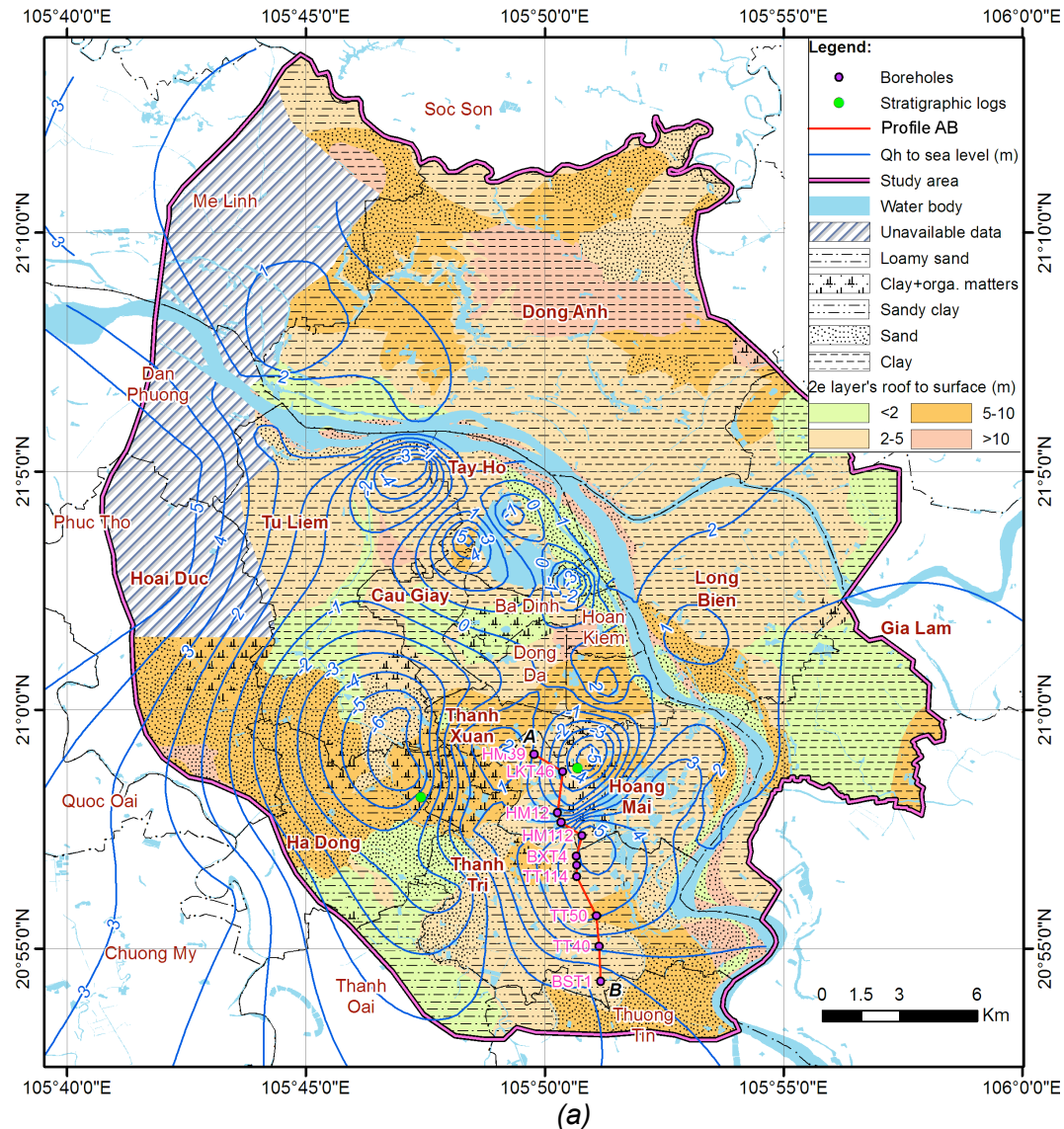
**Fig. 6:** (a) Monitored area by leveling in the Van Quan residential zone. For location of monitoring zone by leveling, refer to Figure 4b, and **SP** pixel in the area (Color scale, refer to Fig. 3). (b) Leveling subsidence graph of blocks TT18A, TT18B (after Dinh et al., 2008). (c) Graphs of one **SP** located at blocks TT18A, TT18B and its leveling measurement. In order to adjust one set of data to the other one, we arbitrary position the regression line of the leveling data through the third point of our InSAR time series.



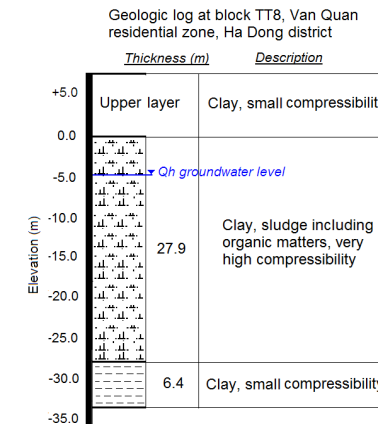
(b)



(c)



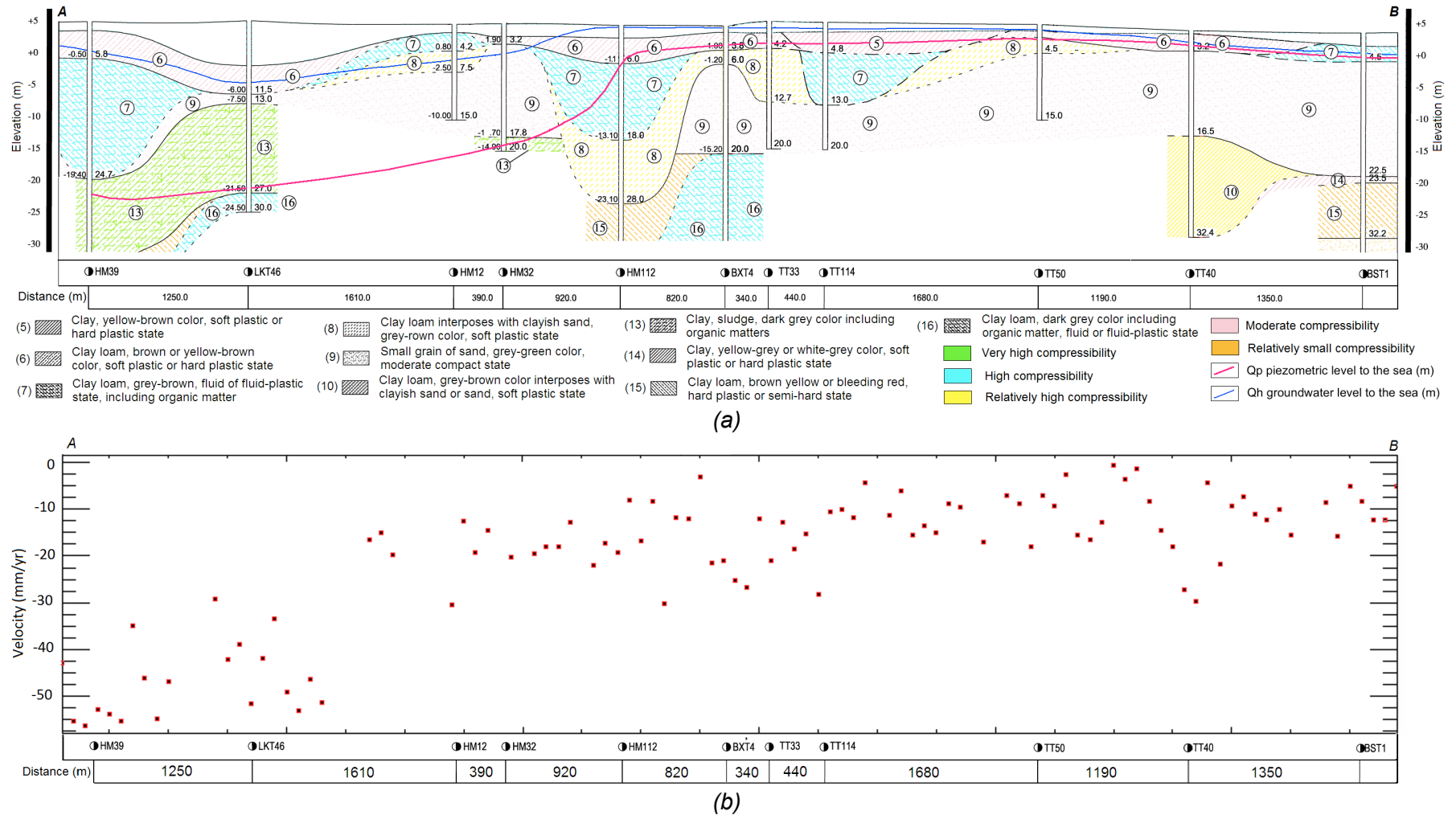
(b)



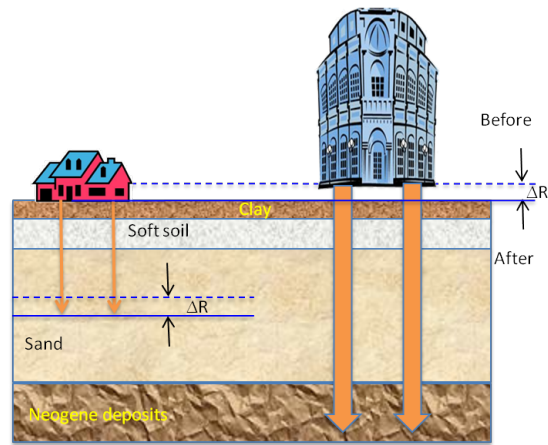
(c)

**Fig. 7:** (a) Geological map of second layer, (after Nguyen, 1996a) and averaged groundwater level in Qh aquifer interpolated from in situ measurements in 32 wells (after Vietnam Institute of Geosciences and Mineral Resources, 2010). Stratigraphic logs at (b) Hoang Mai district, (c) Ha Dong district, (after Nguyen, 2009).





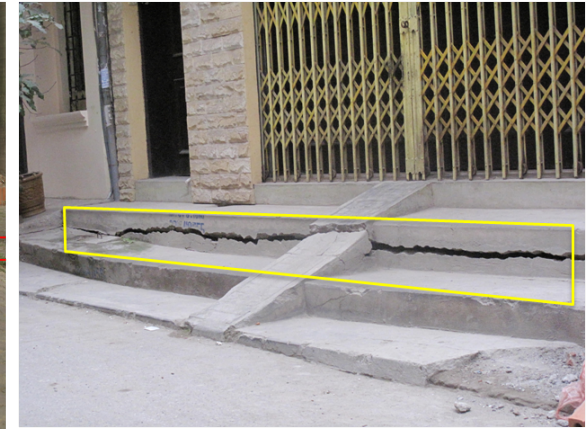
**Fig. 8: (a)** Geologic profile AB of first subsidence area, (modified from Nguyen, 2005), groundwater level in Qh aquifer (blue), (after Vietnam Institute of Geosciences and Mineral Resources, 2010), and piezometric level of Qp aquifer (red), (after the Northern Division of Planning and Investigation for Water Resources, 2010). For spatial pattern of isocontours, refer to Fig. 11. **(b)** Graph of InSAR vertical velocity following the profiles AB. For location of profile AB, refer to Fig. 7 or Fig. 11.



(a)



(b)



(c)



(d1)

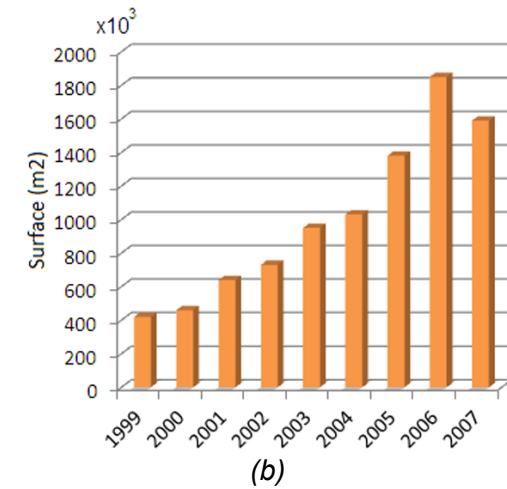
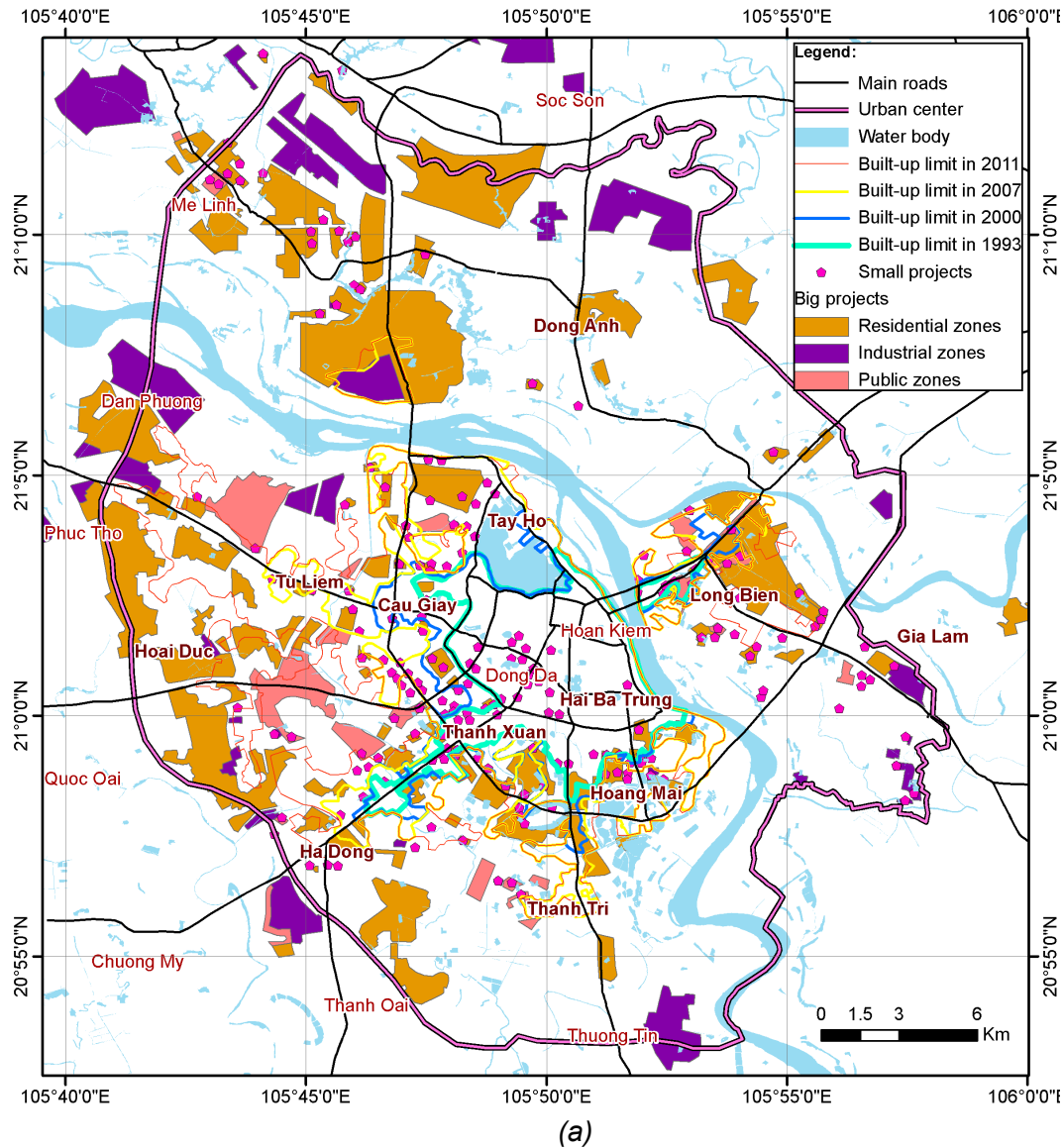


(d2)



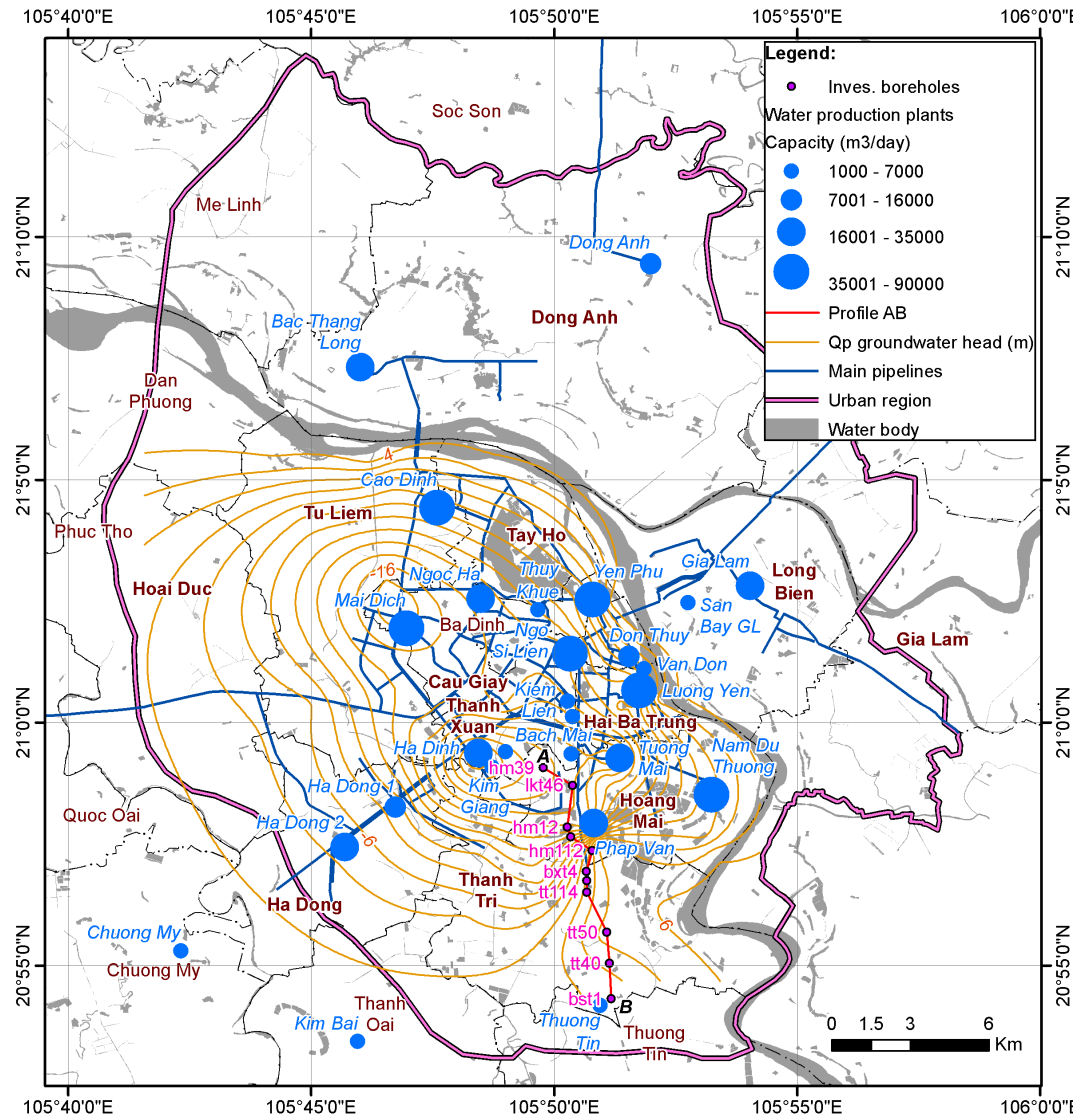
(d3)

**Fig. 9:** (a) Model of subsidence process. Example of subsidence damages in (b) Dinh Cong residential zone at Hoang Mai subsidence area. (c) Van Quan residential zone at Ha Dong subsidence area. For location of investigation points, refer to Figure 3. Several type of foundation is using in study area: (d1) Auger-cast piles, (d2) Concrete pillars, (d3) Bamboo piles (after: <http://www.cocbetong.vn>)

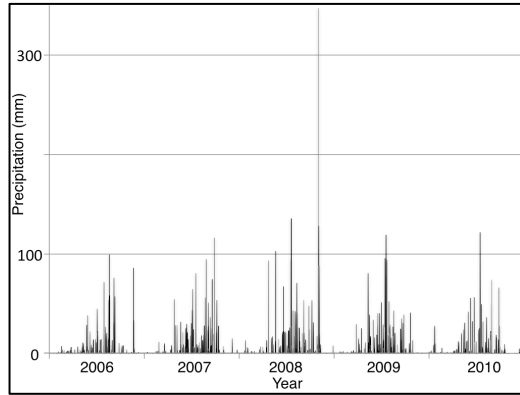


**Fig. 10:** (a) Location of new construction projects by public construction companies in urban region of Hanoi City, (after NARENCA, 2010) and evolution of built-up surfaces until 1993, 2000, 2007, 2011 digitized from Landsat images. (b) Evolution of Hanoi housing surfaces constructed ( $\times 10^3 \text{ m}^2$ ) from 1999 to 2007, (after Hanoi Department of Construction, 2009).

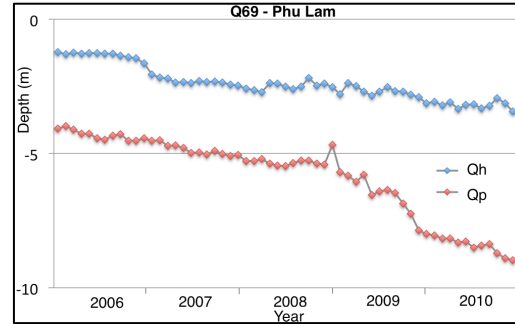




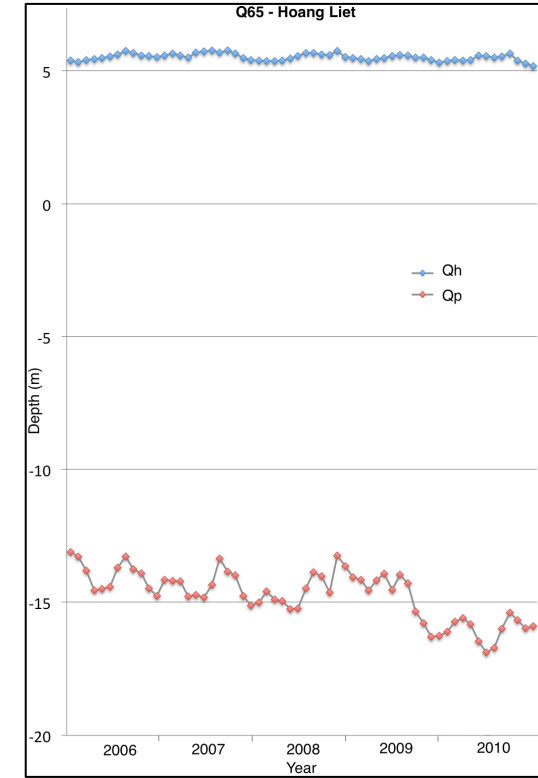
**Fig. 11:** Isocontours of the averaged groundwater piezometric level (to sea level) in Qp aquifer of Red River's southern part interpolated from in situ measurements in 21 wells during 2006 (after the Northern Division of Planning and Investigation for Water Resources, 2010) and withdrawal capacity of Hawaco water production plants, (after Hanoi Department of Planning and Architect, 2011).



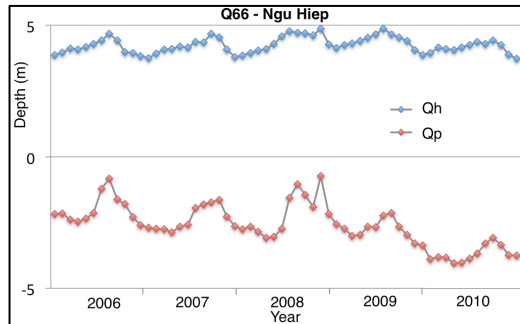
(a)



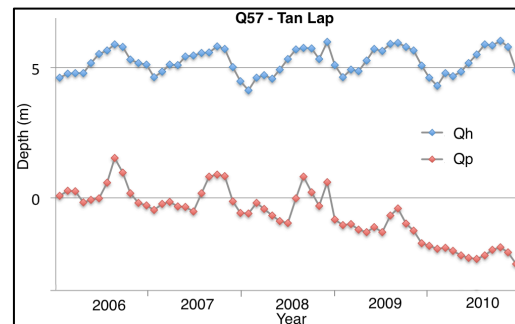
(b)



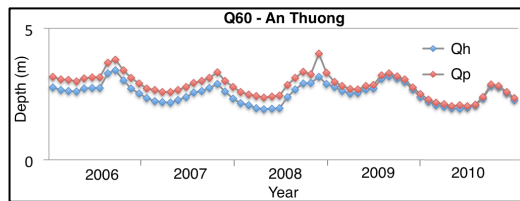
(c)



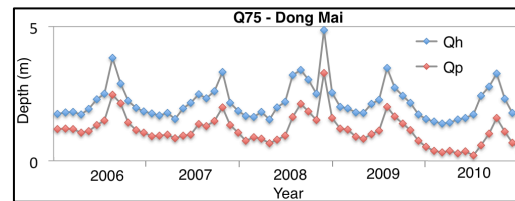
(e)



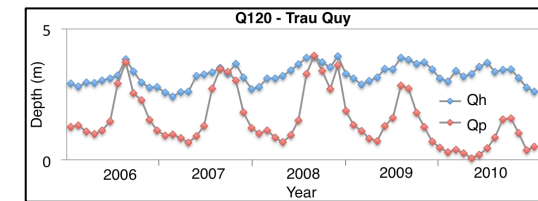
(d)



(h)



(g)



(f)

**Fig. 12:** (a) Precipitation at Lang meteorological station from 2007 to 2010, (after National Hydro-Meteorological Service, 2011). Average groundwater and piezometric level in Qh, Qp during the 2006-2010 period at: (b) Q69 at Phu Lam, Ha Dong, (c) Q65 Hoang Liet, Hoang Mai, (d) Q57 at Tan Lap, Hoai Duc, (e) Q66 Ngu Hiep, Thanh Tri, (f) Q120 at Trau Quy, Gia Lam, (g) Q75 at Dong Mai, Ha Dong, (h) Q60 at An Thuong, Hoai Duc, (after Nguyen and Nguyen, 2007, 2008; Nguyen and Pham, 2009, 2010; Nguyen et al., 2011). For location, refer to Fig. 3