行政院國家科學委員會專題研究計畫　成果報告

臺灣大地構造活躍區淺層地下水位對地質變動的反應(II)-屏東平原同震地下水位空間分布分析

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計畫主持人：郭欽慧

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題目：臺灣大地構造活躍區淺層地下水位對地質變動的反應(II)
-屏東平原同震地下水位空間分布分析

Shallow Groundwater Responses to Geological Events in Active Tectonic Subsidence Settings (II) – A Spatial Coseimic Groundwater variations in the Pingtung Plain

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執行期限：94 年 8 月 1 日至 95 年 7 月 31 日
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執行機構及單位名稱：私立中國文化大學地質系

一、 中文摘要

本計劃主要是研究對台灣大地構造活躍區內淺層地下水位對地質變動的反應。為瞭解活躍大地構造中，淺層地下水位對不同時間尺度的地質變動反應，本計劃去年以長期的時空變化切入，其中GPS資料顯示台灣南部屏東平原區域與東臨的中央山脈同屬於大地構造下陷區域。InSAS影像也同樣顯現了相同趨勢。對於長期下陷區域的地下水趨勢應該會以上升來相對應，在屏東平原南段區域長期地下水趨勢確實是有上升的趨勢, 不過在更靠沿海地區的長期地下水趨勢卻是下降的趨勢。本年度（九十四年度）本人延續構造活躍區內淺層地下水位對地質變動的反應的研究，把觀察重心移至同震之時，空間上淺層地下水位瞬間的分布以是受何種機制控制? 我們發現在921地震時之同震地下水位下降都集中於平原的中部及東部但是位於西部丘陵附近有七口井之地下水位上升。地震後，本區域中有三口井水位永久上升另外有五口井水位永久下降。
關鍵字: 構造活躍區、同震地下水位、淺層地下水位。

二、 英文摘要

We examined both co-seismic and post-seismic changes in groundwater level following the 1999 Chi-Chi earthquake in the Pingtung plain. The spatially coseismic change distribution shows two major increased centers in the study area. Most wells lowered the water level during both co-seismic and post-seismic. Water level raised primarily near the western foothill area. Three near foothill wells however changed water level permanently after 921 earthquake to increase the water level, while five wells lowered their water levels permanently in the central and eastern plain area.

Keywords: active tectonic, subsidence, shallow groundwater level, GPS.

三、 緣由與目的

The previous proposal has studied the long-term changes of the Pingtung plain. This one we continue working in the same area yet have shifted to the short-term changes, particular at and post Chi-Chi earthquake (1999/9/21). We analyzed the co-seismic spatial distribution patterns and the post-earthquake changes up to 350 hours to examine whether the hydrogeological parameters and groundwater flow system have changed since Chi-Chi Earthquake in the study area. Despite we are aware of the coseimic water level changes during Chi-Chi earthquake are not as much as that in the central Taiwan. We intend to use the distance as a filter to examine the stress and strain models under this situation. Since the study area is a thick unconsolidated Quaternary sediments should have the chance to reflect the long-term and short term active tectonic activities.

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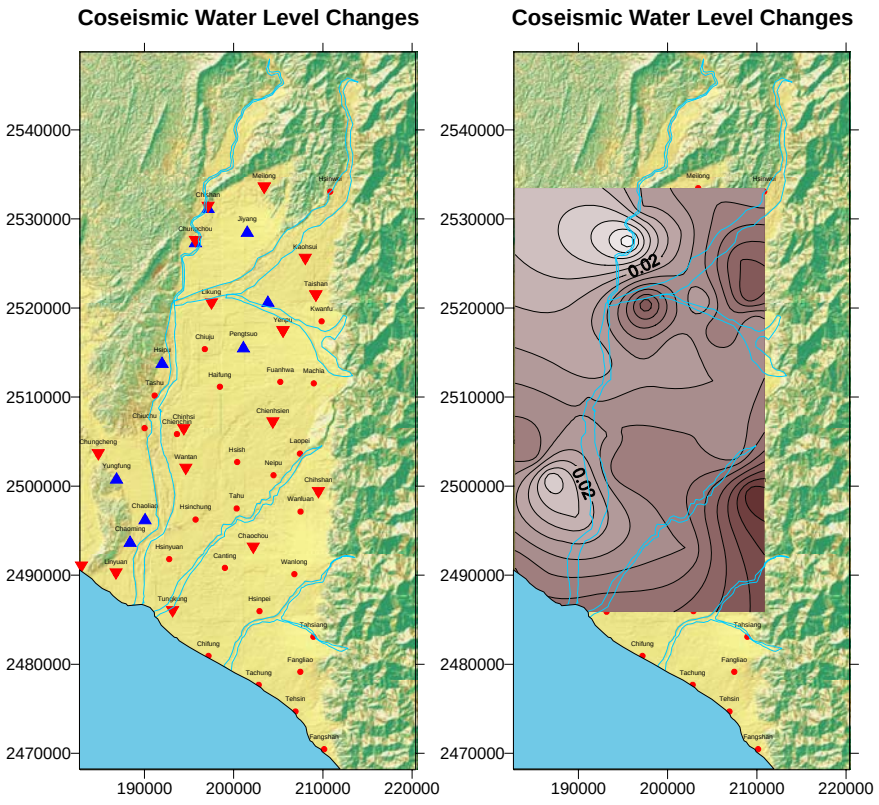
四、 結果與討論

I. Coseismic changes and its Spatial Distribution

Figure 1 shows the coseismic water level change at 921 Chi-Chi earthquake in the shallow aquifers(< 300m) in the study area. Figure 1(a) shows coseismic water level fluctuations; blue ones show increased in water level while red ones indicate water levels dropped. Most wells showed water increase are located in the eastern part of the Pingtung plain near the foothill region while most wells decrease in water levels are located in the central and eastern part of the plain especially near the ChaoChou Fault(Figure 1). Figure 1b shows the counter map of coseismic water level changes. Two peak centers were observed for the coseismic changes. Compare to the general regional flow pattern, higher water level in the northeastern and lower water level in the southwestern region, there are several significant changes. First of all, groundwater flow dipped toward the Chao-Chou Fault in the east instead of in the southwest. Second, the higher water level changed from northeastern to northwestern. Meanwhile the lower water level region changed from southwestern region to the east. However, this change only exists in a short period of time. The flow pattern in general in the study area soon returns to its original pattern, flowing from northeast to southwest even with some permanent change water levels.



(a) **(b)**

Figure 1. (a) the coseismic groundwater levels in shallow aquifer, and (b) is the contour map of the coseismic changes.

II. Post earthquake Water level Variations

We also examined post earthquake water changes. Seven wells increased water level coseismiclly, but only three wells water level permanently changed upward (Figure 2). In the mean time, there are five wells decreased permanently(Figure 2).

We also examined the post-earthquake flow pattern. Figure 3 shows no significant groundwater flow pattern change after 921 Chi-Chi earthquake in the study area, despite some of local peaks temporally exist. This indicates that the 921 Chi-Chi earthquake has much less impact hydrological parameters in the study area compare that in the central Taiwan (Wang et al, 2005; and Wan et al, 2004). In addition, there is no permanent flow pattern change like that in the central Taiwan (Wang et al, 2005).

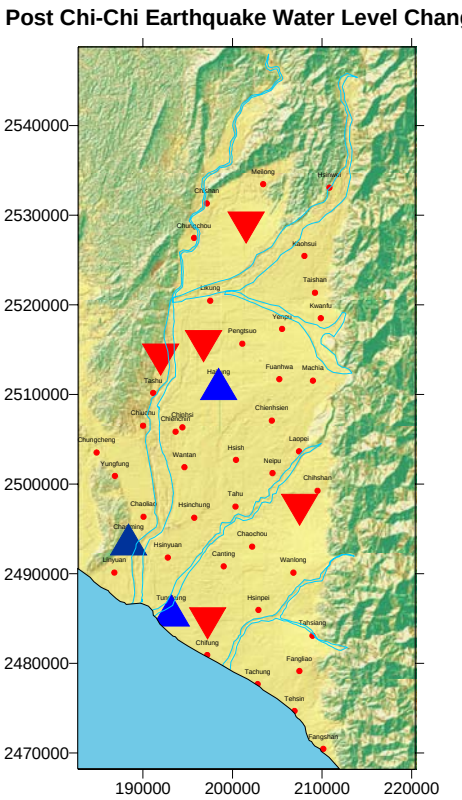


Figure 2 Wells with permanent water level change. Blue triangles indicate water level increased and red ones indicate water level decreased.

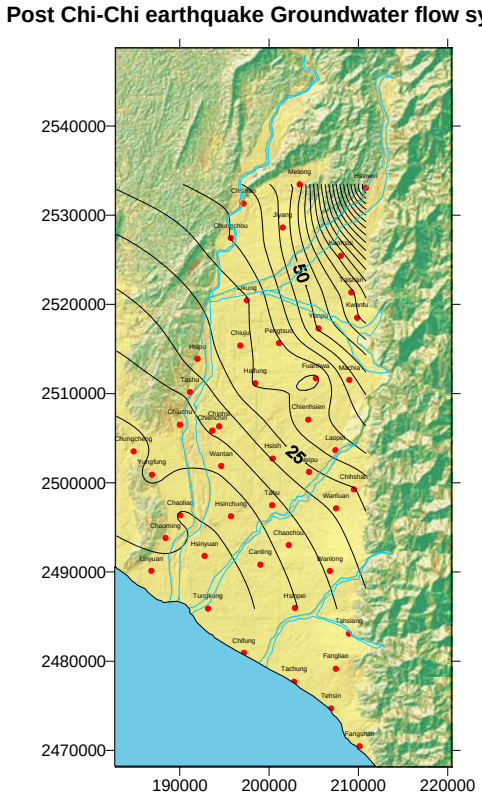


Figure 3 Post Chi-Chi earthquake groundwater flow system returns to its original pattern.

五、 計畫成果自評

We consider this project to be productive due to the fact that we are able to establish the relationship between groundwater level and coseismic and post earthquake changes in the study area. The results are promising and it is needed to look into further in both shorter time scale and in different areas in the future.

1. Most coseismic decreased in groundwater levels were found in the central and east part of the study area while most increased in groundwater levels were observed in the west part.
2. Coseismic changes produced a temporally regional flow pattern dipped toward east in a relative short period of time.
3. Only few wells have permanent change their water level after 921 Chi-Chi earthquake.
4. Even though some wells exhibit permanent change in water level, the general regional flow pattern remains the same.

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