

# Field survey on sinkhole in Pokhara, Nepal

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## Sinkholes in Pokhara

Since Nov. 2013, significant number of sinkholes has been observed in Armala area of Pokhara valley, Nepal (Fig. 2), the abrupt development and increasing frequency pose hazards for local residents. Geologically Armala area consists of recent flood plain containing carbonaceous silty clay and gravel. The characteristic of this silt is that it easily dissolves in the water, the muddy water outlet (observed one week before the first sinkhole) at the downstream river (Fig. 3, at point A in Fig. 4) indicates the evidence that there are erosion within the subsurface of the sinkhole area.



Figure 1 A typical Sinkhole (Nov. 2013)



Figure 3 New water spring<sup>1)</sup>



Figure 2 Armala area

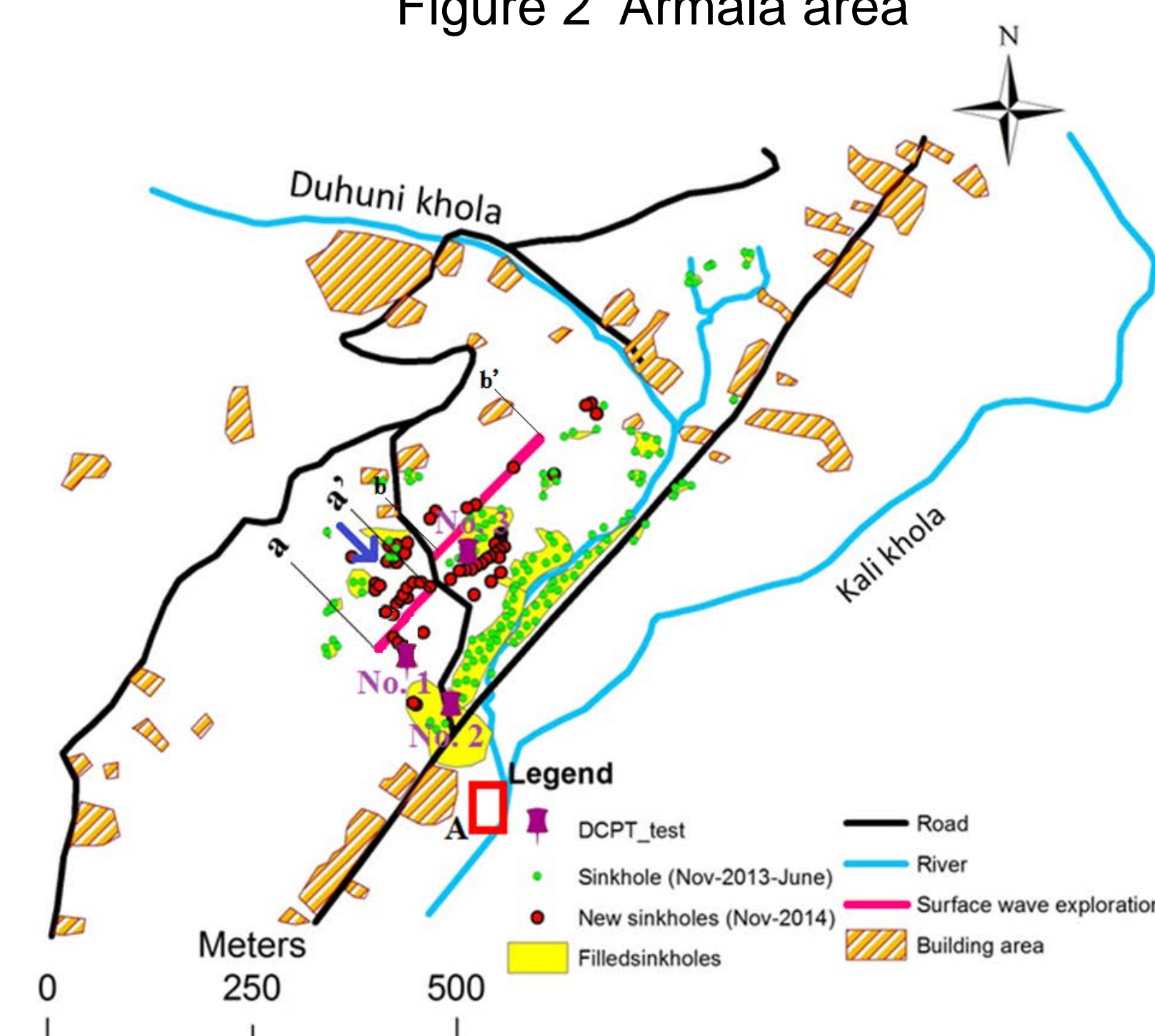


Figure 4 Map of sinkhole damaged area in Armala

## Field Investigation

We conducted two field surveys in June and Nov. 2014 at Armala area in Pokhara to investigate the causes and mechanism of sinkholes. In Nov. 2014, we observed a significant number of new sinkholes and reactivated sinkholes as shown in Fig. 5.

### ➤ Dynamic Cone Penetration Test (DCPT)

DCPTs were conducted at points shown in Fig. 4 to find out the thickness of the cavity bearing formation and penetrate resistance of the layers in June 2014. Fig. 6 shows one profile of DCPT at No.1, in Fig. 4. We measured profile of soil layer up to 2.3 m from the surface, but we couldn't continue the test because of a thick gravel layer.

### ➤ Surface Wave Exploration

Surface wave exploration was conducted to investigate subsurface structure in Nov. 2014 (line a-a' and b-b' in Fig. 4). Fig. 7 shows the resultant profile of soil layer along a-a'. Higher shear wave velocity represents more stiff layer observed at below 5 m from surface. The result shows that a loose soil layer observed below the stiff soil would indicate cavity formation.



Figure 5 June 2014 (left) and November 2014 (right)

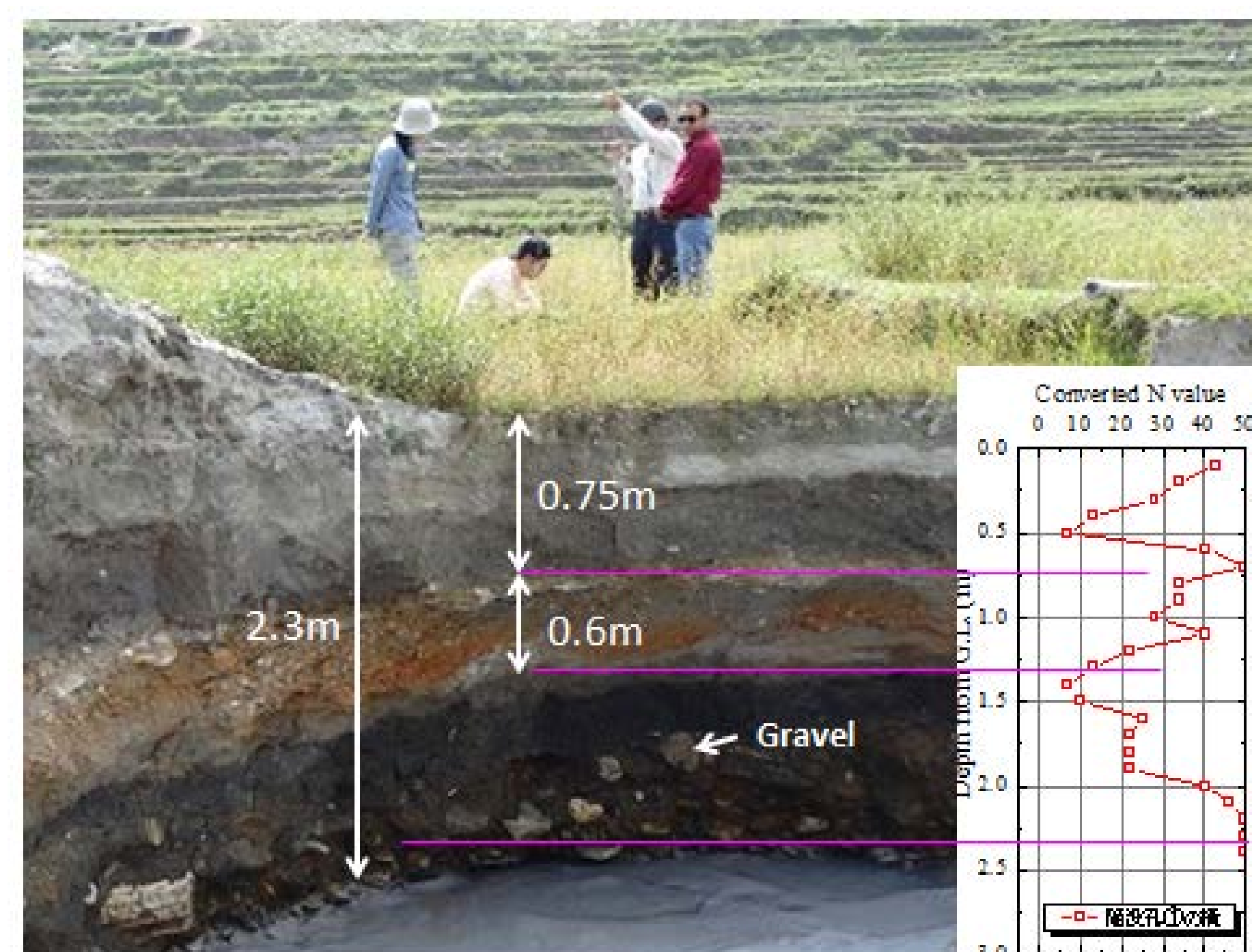


Figure 6 DCPT result

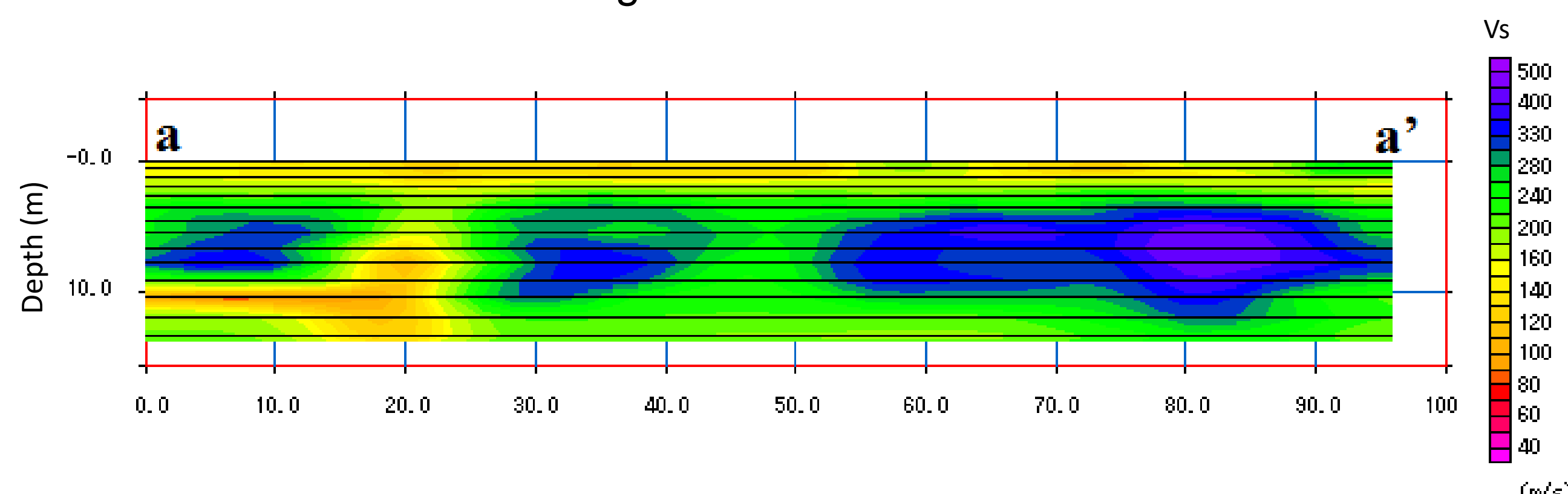


Figure 7 Profile of surface wave exploration

References: 1) Technical Research Team (2014): Technical research report of ground subsidence at Jaimure phant, Armala V.D.C., Kaski District. Technical Report, Pokhara, Kaski.