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Extendable Geoslicer: A New Technique in Collecting Unconsolidated Sediment and Soil Samples

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Abstract - Geoslicer is a field gear for active fault geology studies invented in Japan, in 1997. It was formerly addressed to overcome some difficulties in studying active faults. Lately, it has also been applied for tsunami, geological, liquefaction geology, geo-archaeology, and Quaternary geology in common. Despite evidently effective in those studies, it still bears several disadvantages. Several modifications and developments have been implemented to eliminate these disadvantages. A new type geoslicer was invented as a result, *Extendable Geoslicer*. This new type geoslicer has been tested and showed good performance in relation with the disadvantages of the old type. Extendable geoslicer is evidently operated more easily, cheaper, handier, and works in all field types.

Keywords: *Geoslicer, fault geology, tsunami geology, paleotsunami, Quaternary geology, sampling technique, field gear*

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Introduction

Effective and efficient techniques for data and samples collection in the field is a key in active fault study. The most common accepted technique is trenching. Several trenching are usually conducted crossing inferred lines of past faulting. Trench dimension varies from several to hundred of meters in length, 2 - 6 m in width and to about 3 m in depth. In spite of its effectiveness, trenching is time consuming and expensive to some distance. For overwhelming this problem, a technique using a new gear namely geoslicer was proposed by Nakata and Shimazaki (1997).

Geoslicer is a field gear designed for collecting a vertical section of undisturbed and unconsolidated samples (Figure 1). Fukken Co. Ltd. owns the patent right of the gear (Patent No. 2934641, 1999) (Hino *et al*., 2013). Although it was previously addressed to overcome difficulties in conducting an active fault study, other fields such as tsunami, geological liquefaction, geo-archaeology, Quaternary geology, and geo-technique have also currently been benefited from the invention of the gear (see for examples: Haraguchi *et al*., 1998; Kazama *et al*., 2007; Sawai *et al*., 2008; Normile, 2011; Shishikura *et al*., 2011; Goto *et al*., 2012; Sawai *et al*., 2012; Fujiwara *et al*., 2013; Hino *et al*., 2013; Watanabe *et al*., 2014).

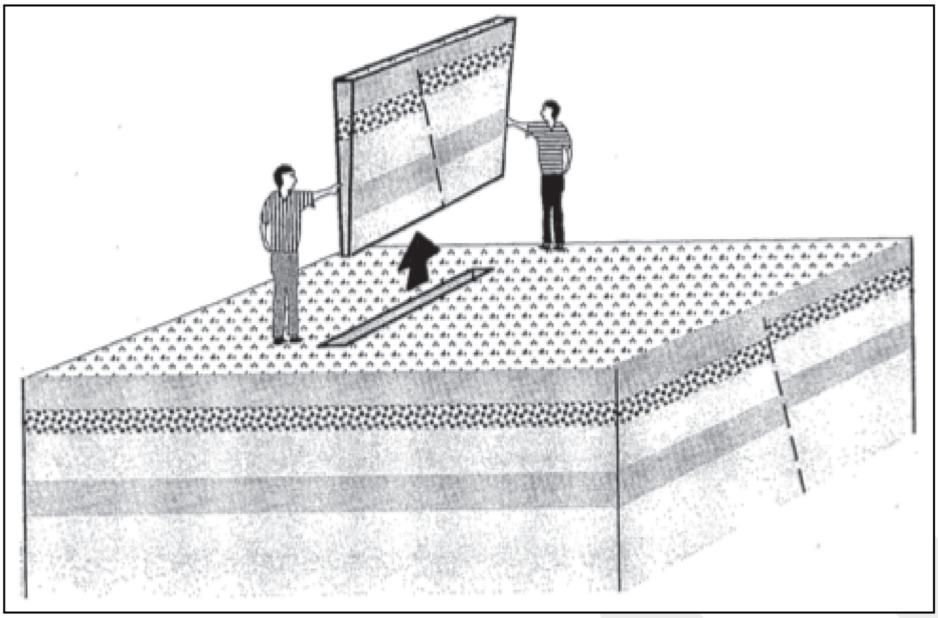

Figure 1. Basic idea of *geoslicer*. *Geoslicer* is designed to extract vertical unconsolidated soil profiles (Nakata & Shimazaki, 1997).

Despite of its effectiveness, a geoslicer bears several disadvantages relating to operation techniques. Fukken Co. Ltd. in Hiroshima, Japan, manufactures its handy types in two different dimensions, 200 x 10 x 2 cm and 60 x 5 x 1 cm. Both types are made of 1-mm steel. The 200 cm type is operated using a handy vibrator to penetrate sediment and soil profile, and the 60 cm type is by hammering. The main disadvantage of these types is their fixed penetration range (200 cm and 60 cm). Additionally, due to the thin steel plate, they often cannot go deeper and getting damaged when it encounters hard or loamy layers, and boulders.

Fukken Co. Ltd also manufactures the large type geo-slicer in a dimension of 150 x 100 x 8-15 cm and 400 x 150 x 20 cm. These types are operated by a large vibrator and a back-hoe. These types are evidently very effective for active fault and tsunami studies. The disadvantage of these types is their impracticability and inefficiency in term of operation budget.

All geoslicer types manufactured by Fukken Co. Ltd. is not equipped with "inner" box. Consequently, quick observation of extracted sediment and soil profiles should be conducted in the field. For rigorous observation of the profiles in laboratory, peels of profiles are made prior to samples collection for laboratory works. This gives another disadvantage particularly on limitation of sample volume for laboratory analysis.

A new type geoslicer is proposed to overcome those disadvantages. This new type was designed to fulfill several criteria i.e handy, easily operated, effective & efficient in terms of operation budget and time, compatible for any kind of field, and extendable to reach any depth. This paper presents this new geoslicer type namely *extendable geoslicer* that was designed and developed in Research Center for Geotechnology, Indonesia Institute of Sceinces (LIPI). It has been being registered to get a patent right in Indonesia (Registration No. P00201304923, 2013).

Basic Structure of GeoSlicer

Basic structure of geoslicer invented by Nakata dan Shimazaki consists of a *steel sample box* and a *shutter* (Figure 2). The U-shape sample box is equipped with a narrow slit in each side to guide the shutter plate. It has a simple opera-

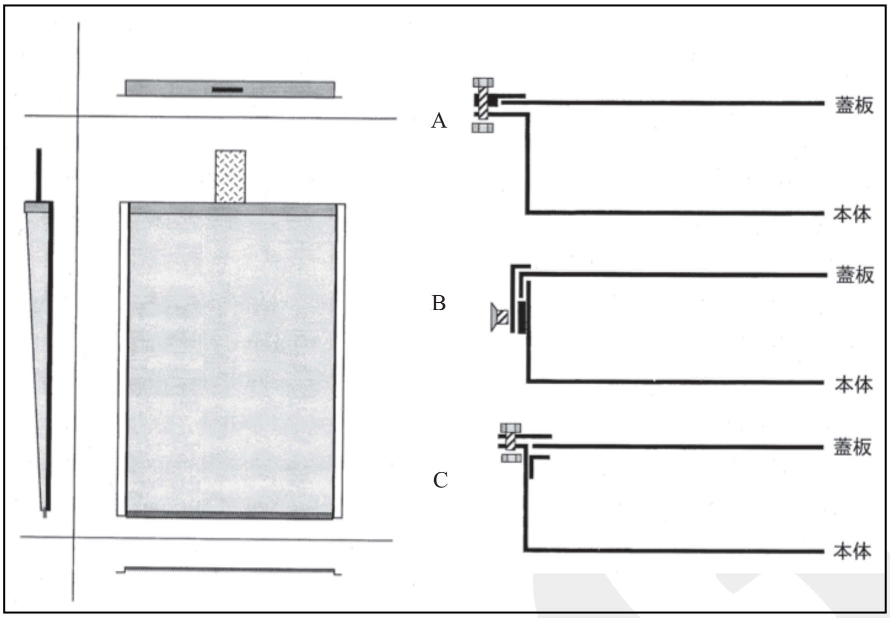

Figure 2. Basic structure of geo-slicer consists of: (a) a steel sample box and a shutter (Nakata and Shimazaki, 1997); (b) Several connection features of sample box and the shutter: A. Narrow slits for small type geoslicer; B. Firm but rather complicated slits for a medium-size geoslicer; C. Guide slits on the inner wall of the box for a large geoslicer.

tion technique by piling the steel sample box to the ground and pushed inside the ground using vibrator or hit using rubber hammer. The bottom end of shutter plate is then railed in the slit and pushed using vibrator or hit using rubber hammer. The filled-in geoslicer is pulled out of the ground by manual or vibrated leveraging

Structure of the Extendable GeoSlicer

Extendable geoslicer is basically modified and developed type of the geoslicer invented by Nakata dan Shimazaki (1997). Modification is made on the slit position. Development is focused on the extendable rod with clung hammer and cylinder shock, and the sample catcher with U-shape inner sample box (Figure 3).

The length of sample catcher is designed in respect to the length of the rod. Two optional sample catchers and rods with thread connection is designed, 100 cm and 60 cm. These relatively short catchers are designed to reduce the friction and total weight of sediment filled-in sample box, facilitating pushing-in and pulling-out the geoslicer of the soil. The rods with thread connection enables the geoslicer to extend to any necessary depth.

The sample catcher has 12 cm width and 2 cm thickness. The width of the catcher is designed in respect to the widest and most common gutter in the markets that is used for inner sample box. To keep the inner sample box stilled in its position, the bottom edge of the box is inserted in narrow clips attached at the bottom end of the steel box, and the top edge of the box is screwed to the holes at the top end of steel box. This inner sample box enables continues operation of the geo-slicer because sediment filled-in inner box is easily pulled out of the steel box and replaced by the new one. All extracted samples can be brought to the laboratory for rigorous observation and sampling.

Cylinder iron hammer clings directly to the rod, coupling with the cylinder iron shock. Thick rubber is attached on the surface of iron shock to generate vibration effect during hammering. The shutter plate is also clung to the rod using a hollow pipe extension. Narrow slits attached to the both sides of shutter plate. The hollow pipe extension and the slits guide the shutter plate to keep gliding on the rails at the edge of the steel box.

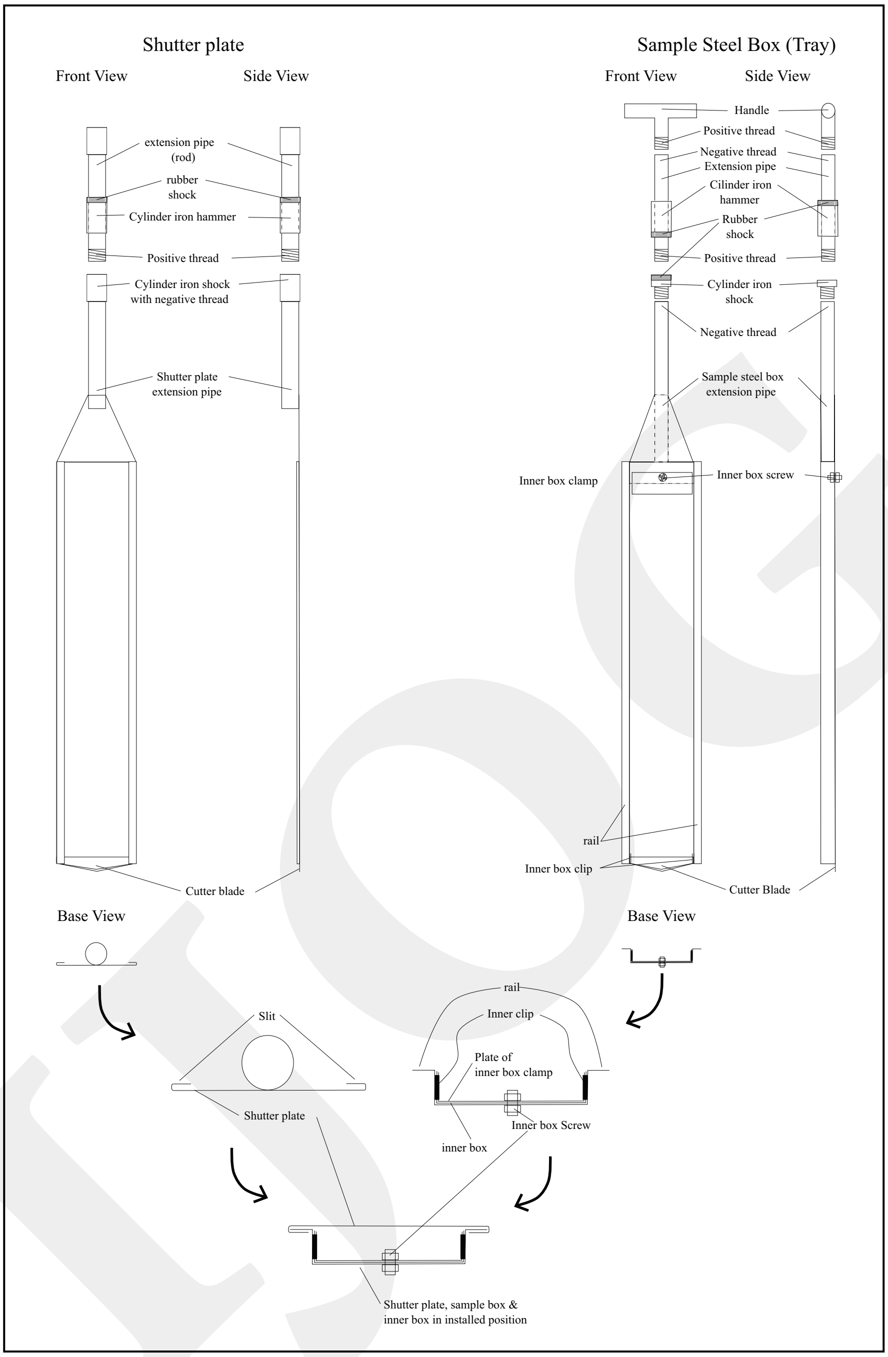

Figure 3. Structure of extendable geoslicer. Extendable rods with thread connection, handle with thread connection, cylinder hammer coupling with cylinder iron shock clung to the rod, and inner sample box are the main differences from geoslicer invented by Nakata dan Shimazaki (1997).

Handle of extendable geoslicer is designed with thread connection, and easily connected to the extension of sample catcher, and to the rod. The handle is used to push the sample catcher in and pull it out of the soil manually. It is also used to put the bowknot when a pulley is operated to pull the geoslicer out of the ground.

Performance Test of the Extendable GeoSlicer

Field tests have been conducted to reveal the performance of the extendable geoslicer. The first test is conducted in the Lembang Fault sagpond deposit (Figure 4). Extendable has been

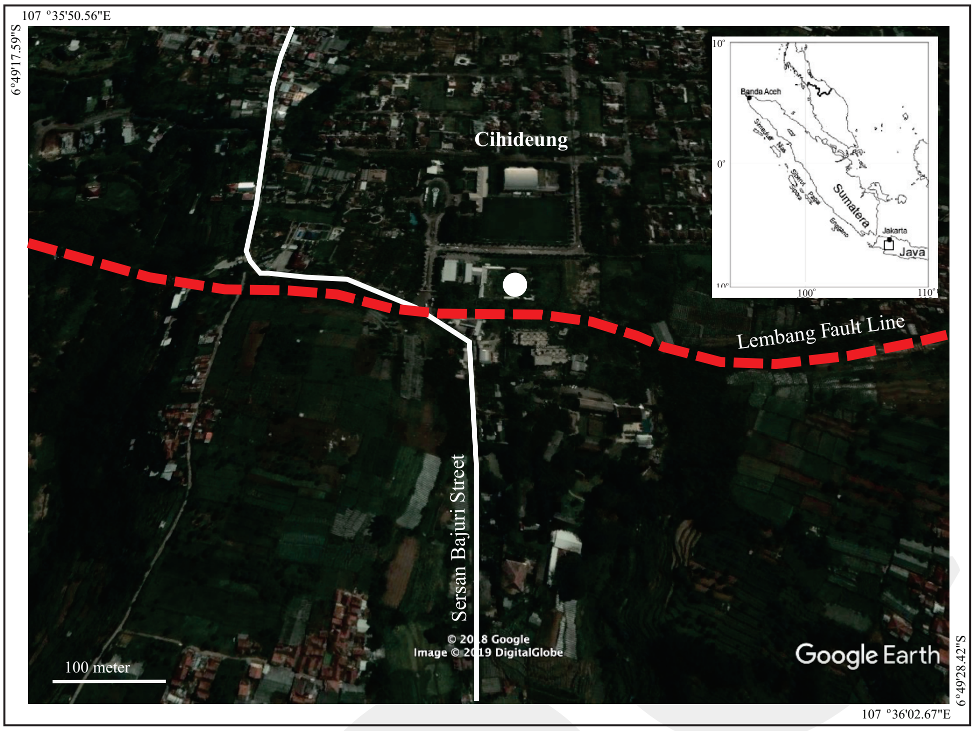

Figure 4. Locality map of a Lembang Fault sagpond (white dot), where field tests of extendable geoslicer has been carried out.

operated in two sites. In site 1, a-320 cm vertical sediment profile section was successfully extracted. The geoslicer stopped at 320 cm and could not go deeper. It encountered layers of landfilled-deposit, sand tephra deposits, and peats (Figure 5).

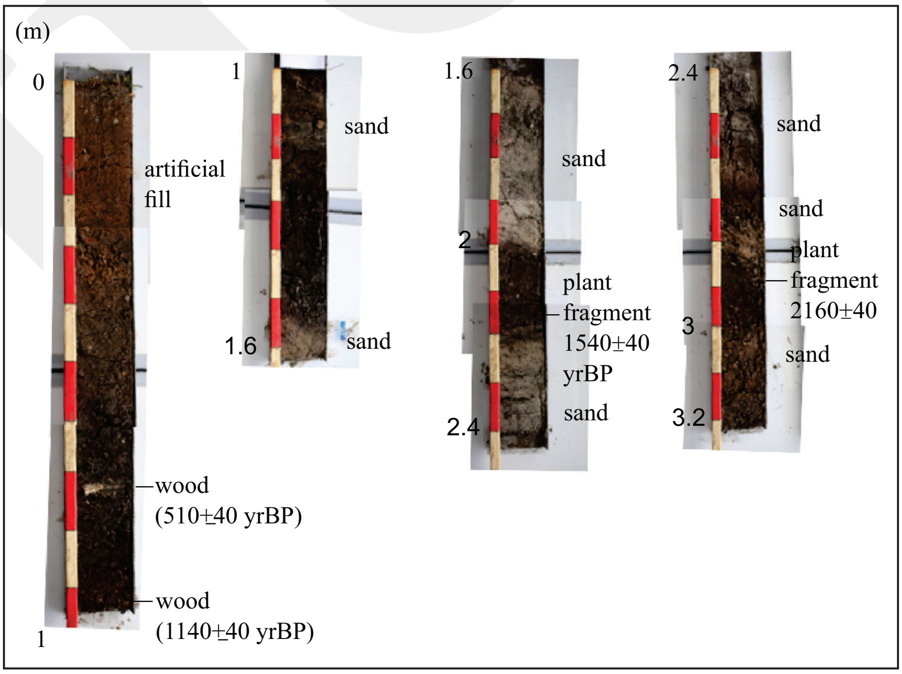

Figure 5. A-320 cm sample in the inner sample box extracted from the Lembang Fault sagpond deposit as an evidence of extendable geoslicer performance. The sagpond deposit stratigraphy is obviously observed and shown with datings at some layers.

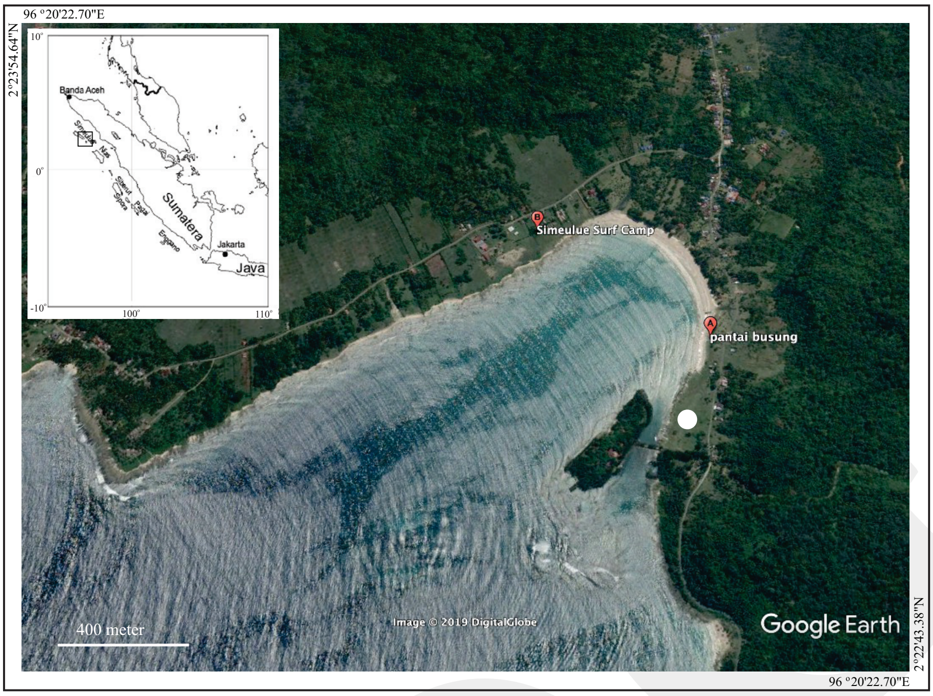

Figure 6. Locality map of a coastal plain deposit, where field tests of extendable geoslicer has been carried out in Busung Bay (white dot), Simeulue Island.

The second test was conducted in Simeulue Island, in sediment profile of coastal deposit (Figure 6). The geoslicer stopped at 60 cm due to encountering hard coral platform. The soil stratigraphy consists of a series of tsunami deposits of the 2005 Nias tsunami, the 2004 Indian Ocean tsunami, as well as the presumably 1907, 1861, and 1797 tsunamis (Figure 7).

The third test was conducted in Lampuuk, Aceh Besar, in sediment profile of coastal deposit. (Figure 8). The sediment profile extracted was only 50 cm. It consists of thin post-the 2004 Indian Ocean tsunami soil, the 2004 Indian Ocean tsunami deposit, and layers underneath (Figure 9).

These tests and extracted samples show the good performance of the extendable geoslicer in extracting undisturbed samples of sediment and soil profiles. All the extracted samples were in 12 cm wide and 2 cm thick. They show obvious stratigraphy and sedimentary structures and textures of the profiles. Moreover, the extracted samples provide sufficient materials for laboratory examination.

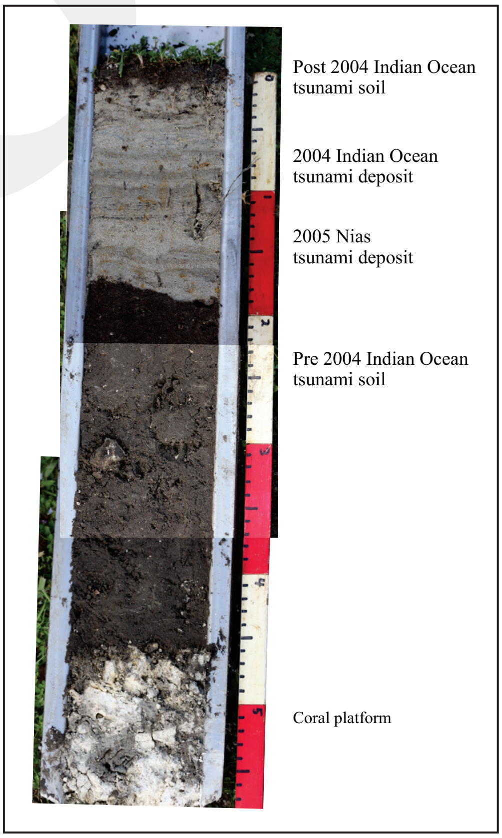

Figure 7. Extracted sediment profiles taken using extendable geoslicer showing a-60 cm extracted sediment profiles taken from Busung Bay Simeulue Island.

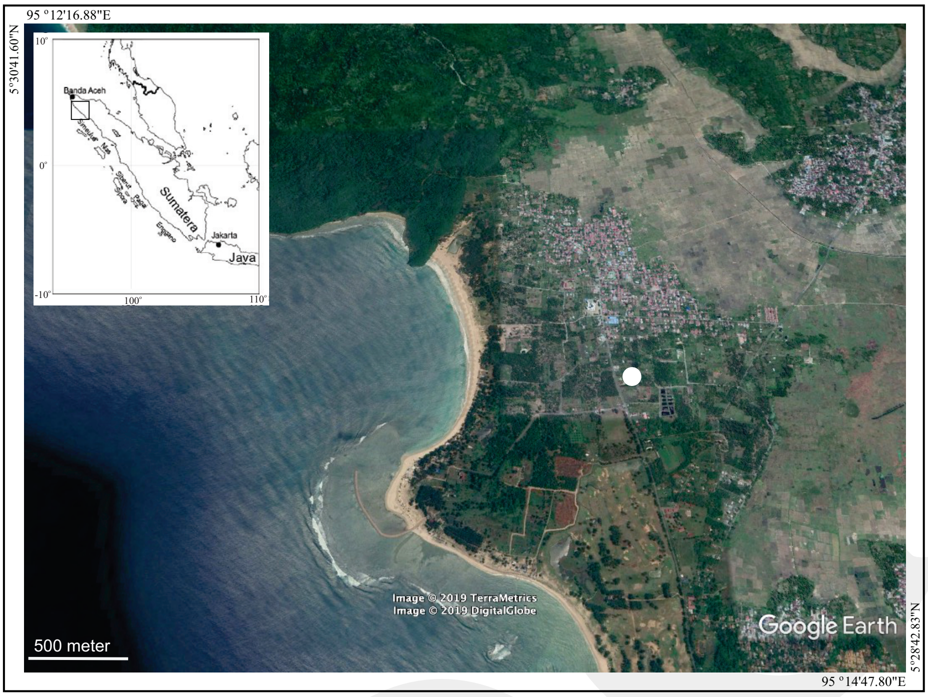

Figure 8. Locality map of a coastal plain deposit, where field tests of extendable geoslicer has been carried out in Lampuuk, Aceh Besar.

Figure 9. Extracted sediment profiles taken using extendable geoslicer showing a-60 cm sediment profiles taken from Lampuuk, Aceh Besar.

Conclusion

Several modification and development have been implemented in order to increase the performance of geoslicer invented by Nakata dan Shimazaki in 1997. As a result, a new type of geoslicer has been invented, extendable geoslicer. Field tests in three sites show a good performance of this new gear in extracting unconsolidated and undisturbed soil and sediment layers. The extendable geoslicer has been registered to the patent office of Indonesia (Reg. No. P00201304923, 2013).

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