Peri-urban areas, morphological evolution and hazards: The case of Rio city, Northern Peloponnese, Greece

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Keywords: Peri-urban areas, Rio, Peloponnese, hazards, morphology, evolution

Abstract

Morphological evolution and its relationship with peri-urbanization is becoming an increasingly interesting and significant topic, due to the high impact that it has on highly sensitive areas.

Our study area is the city of Rio in northern Peloponnese, located approximately 7 km far from the city of Patras. With a population of around 15.000 inhabitants, is considered to be a highly sensitive area, because of numerous and important infrastructures, such as the University of Patras, the local University hospital, two sports halls and the Ottoman era fortress located at the coast.

The geology is characterized by the formation of Olonos – Pindos zone, including Pliocene and Pleistocene sediments, covered by Quaternary and alluvial deposits and dislocated by faults with NE-SW and NW-SE direction.

Geochronological and sedimentological studies of dated raised terraces found an average uplift rate of 0.4 to 6 mm/yr while the dating results indicate pre-Tyrrhenian to Tyrrhenian interglacial ages.

Hydrologically, the area is characterized by ephemerous streams and rivers such as Charadros, Selemnos, Volinaios and Foinikas flowing into both the Gulf of Patras and Gulf of Corinth. The area combines sectors of mixed use. Green parts are also present in a currently developing area.

During the years, the area has undergone a series of changes that can be developed into potential hazards. The construction of Patras University in the 1960's and the University hospital in the late 1980's led to the infilling of one branch of the Selemnos River, increasing the risk of flooding of the remaining river branch.

The coastal area suffers erosion introducing risks to the port and coastal infrastructure. Some minor remediation works were unsuccessful. Combined with the high seismicity of the area, the extensive human intervention, high seismicity, and the local tectonics, introduce risks that have to be researched, analysed and controlled.

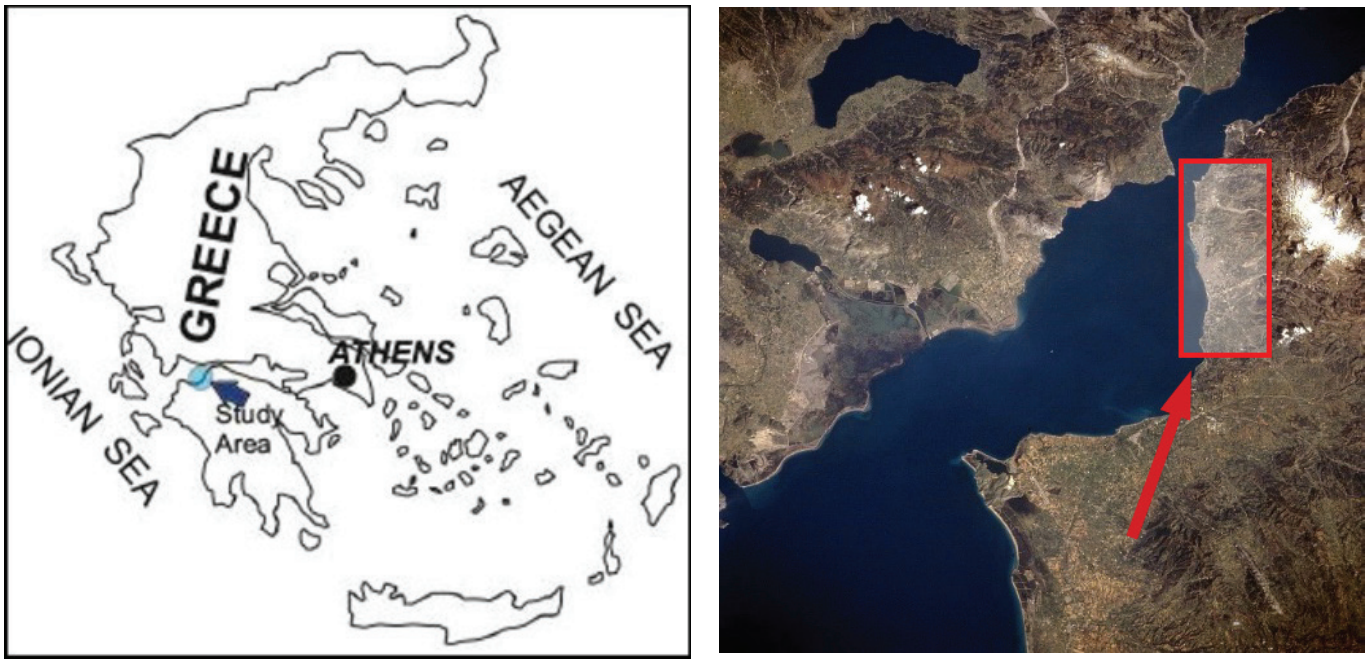
Introduction

Landscape morphology in the field of geomorphology has the meaning of the form and spatial structure of the landscape. Landscape morphology has a direct influence on water movements, soil, physical and chemical properties, and on the productivity of the vegetation cover.

It is used in human geography as the material formation of the landscape, its shaping and reshaping, in which social structures and cultural worlds are enfolded. In other words, it is directly connected with human activity and it is greatly affected by it in an undivided, through the years, way.

Morphological evolution and its relationship with peri-urbanization is becoming an increasingly interesting and significant topic. This is due to the always increasing, but also already high, impact that it has on highly sensitive areas. It can affect infrastructure, touristic areas, zones of high cultural interest, the environment and it can also have an effect on human lives.

In our case, we examine the city of Rio in western Peloponnese. It is located approximately 7 km far from the city of Patras. The municipal unit has an area of around 100,000 km^2 (figures 1a-b).



a b

Figure 1 – The study area (a) in western Peloponnese (b), Greece.

Rio city has a population of around 15,000 inhabitants and is of high interest and a highly sensitive area, because of numerous and important infrastructures, such as the University of Patras, the local University hospital, sports hall and the Ottoman era fortress which is located on the coast and the Rio-Antirio bridge connecting Peloponnese with the mainland (figures 2a-d).

Figure 2(a) – View of infrastructures and sensitive areas in Rio city.

Figure 2b – View of infrastructure and sensitive area in Rio city.

Figure 2(c) – View of infrastructure and sensitive area in Rio city.

Figure 2 (d) – View of infrastructure and sensitive area in Rio city.

Geological Setting

The Patraikos Gulf lies about 100 km east from the Hellenic trench, immediately behind the Plio-Quaternary fold belt, which runs parallel to the coast of western Greece. It is a Plio-Quaternary subsidence area of great structural complexity and crosses the Pindos-Gavrovo and Ionian isopic zones of the western Hellenides. The margin of the graben is marked by numerous faults that have been active in the Holocene.

Rio is the northernmost municipal unit of the Peloponnese. The study area lies in the southern coast of the Patraikos Gulf, surrounded by the pre-Neogene folded rocks of Cape Araxos to the west, of Mt. Panachaikon to the east and of Mt. Skolis to the south. It comprises a thick Upper Tertiary clastic sequence, which overlies unconformably the pre-Neogene basement. The geology is characterized by the formation of Olonos–Pindos zone, including Pliocene and Pleistocene sediments. Most of them are covered by Quaternary and alluvial deposits (Tsiambaos et al., 1997; Rozoset al., 2006).

The study area has an altitude that ranges from 0 (sea level) to 500 m and mainly consists of semi-consolidated Neogene sediments or Quaternary fluvial, alluvial and over bank deposits. It is also characterized by uplifted terraced Quaternary sediments where the Rion-Patras graben and the northeastern part of the Ellis graben are found. From a tectonic point of view the area is characterised by two sets of faults, one of NE-SW and one of NW-SE direction. The Patraikos Gulf area consists the western part of a major East/West graben system, behind the Plio-Quaternary fold belt. This graben system extends from the boundary of a marginal compressional zone associated with the subducting Western Hellenic arc, to the center of the Aegean Sea.

The NW-SE trending grabens of this system (Gulf of Corinth and Megara Basin) are associated with listric normal faulting with the same orientation, and are associated with shallow earthquakes. The NW-trending subsiding areas in the immediate vicinity, like the Preveza Gulf, Lake Trihonis and the Corinthian Gulf are also associated with NE-trending faults.

Urban development

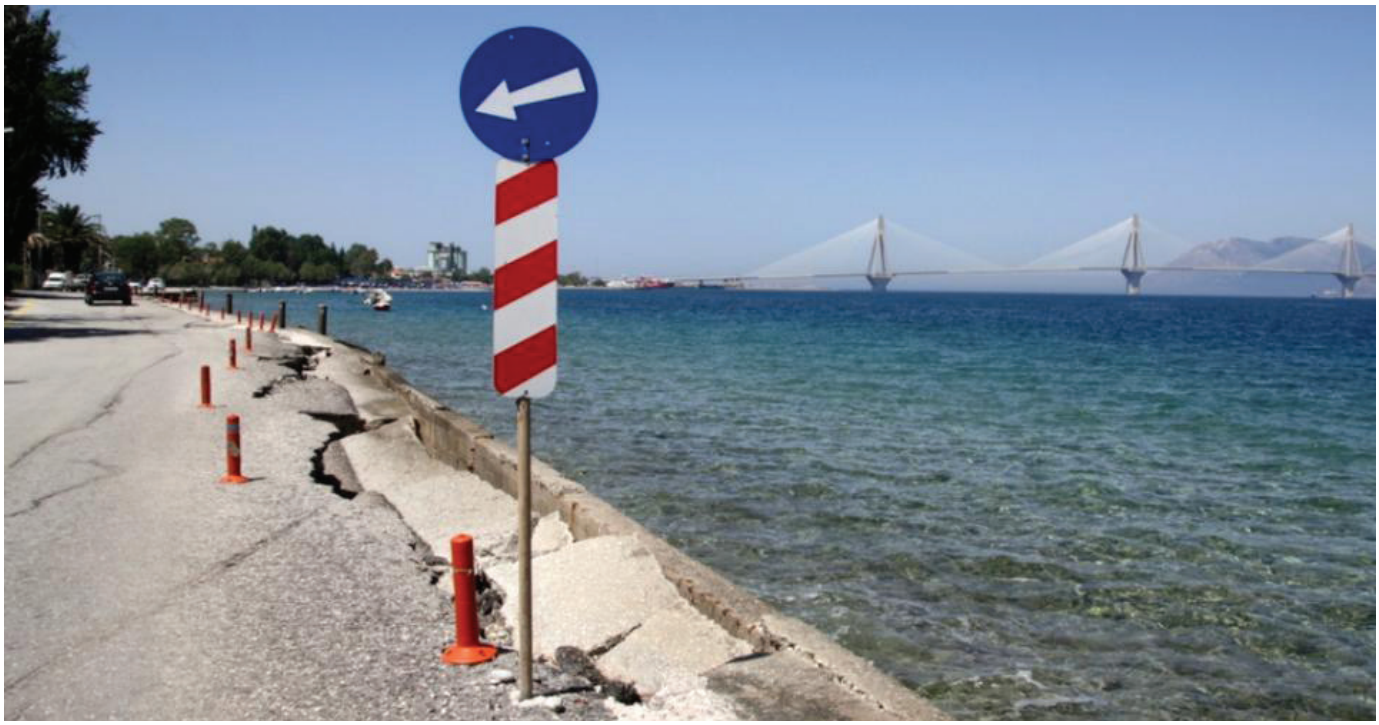
People, urbanization and risk are interconnected factors which are deemed to be very important and have a decisive influence on the population. The growing rate of urbanization and the increase in population density can lead to the creation of risk, especially when urbanization is rapid and poorly planned. The city of Rio, just like the city of Patras, especially from the 1960's, faced a population influx due to inland and refugee migration and earthquakes. The city started to grow significantly and created the need for human intervention on areas that were deemed to be at risk or had to serve the public.

There are numerous characteristics of current urban planning and development that drive vulnerability including the

fact that disaster risk is rarely taken into account in investment decisions. Weak regulation, for instance the lack of enforcement of building codes, planning permission, and regulatory investment lead to the irregular and many times dangerous urban development, especially when combined with the fact that the area is highly seismogenic.

The area is also characterized by a number of active landslides and a number of houses have been built on these active landslides.

Finally, the coastline or Rio is widely exposed to erosion which has created many problems in the past especially to the coastal roads, local port and the foundations of businesses and houses nearby. A few remediating measures are taken, like the use of debris on the coast adjacent to the road and the construction of groins in order to decrease the erosional action of waves were not effective (figures 3a-b). Sediment accumulation was not improved, and the land still retreats.



Figures 3 (a) and (b) – Partial view of a coastal road in Rio city. The signs of erosion and coastal retreat are evident.

Discussion

The landscape morphology in the study area was shaped as a result of the interaction and interconnection between the intense human presence along with fluvial, tectonic and morphoclimatic factors.

Geochronological and sedimentological studies of dated raised terraces (Doutsos et al., 1988; Stamatopoulos et al., 1994, 1998, 2004; Frydas et al., 1995) found an average uplift rate of 0.4 to 6 mm/yr (Stamatopoulos et al., 1994; Kontopoulos & Zelilidis, 1997; Stamatopoulos et al., 1998, 2004) while the dating results indicate pre-Tyrrhenian to Tyrrhenian interglacial ages.

An important point regarding the interpretation of these ages is their geomorphic and stratigraphic context. High rates of coastal uplift have resulted in the intense erosion that has distorted a large part of the marine terraces of the studied area.

Hydrologically, the area is characterized by ephemerous streams and rivers such as Charadros, Selemnos and Volinaios, flowing into both the Gulf of Patras and Gulf of Corinth. The area combines sectors of mixed use (agricultural and urban). Green parts are also present and generally the area is currently developing.

During the years, it has undergone a series of changes that can be developed into potential hazards. The construction of the University of Patras in the 1960's and the University hospital in the late 1980's led to the infilling of one branch of Selemnos river, heightening the risk of flooding of the remaining river branch.

Additionally, as it was foretold, the area is characterized by active landslides. Houses and roads had been built on some of these landslides and as a result, especially in times of prolonged wet periods, the landslides create severe problems. A local road has already fellen, retaining walls and fences used on fields break and a number of houses have been classified as inhabitable (figures 4a-d).

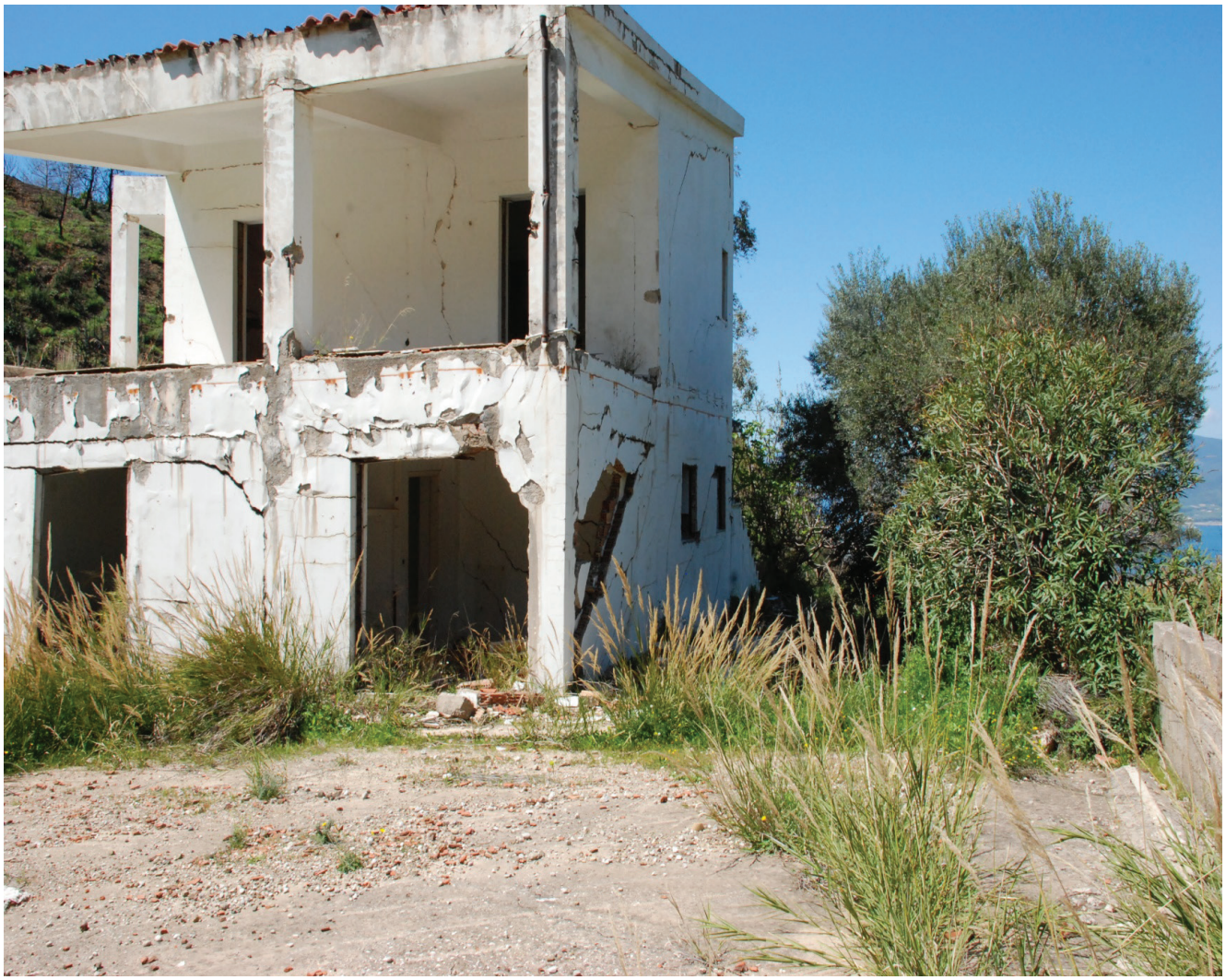


Figure 4 (a) – Infrastructure and building problems in broader Rio area due to landslides, coastal erosion and poor development design.

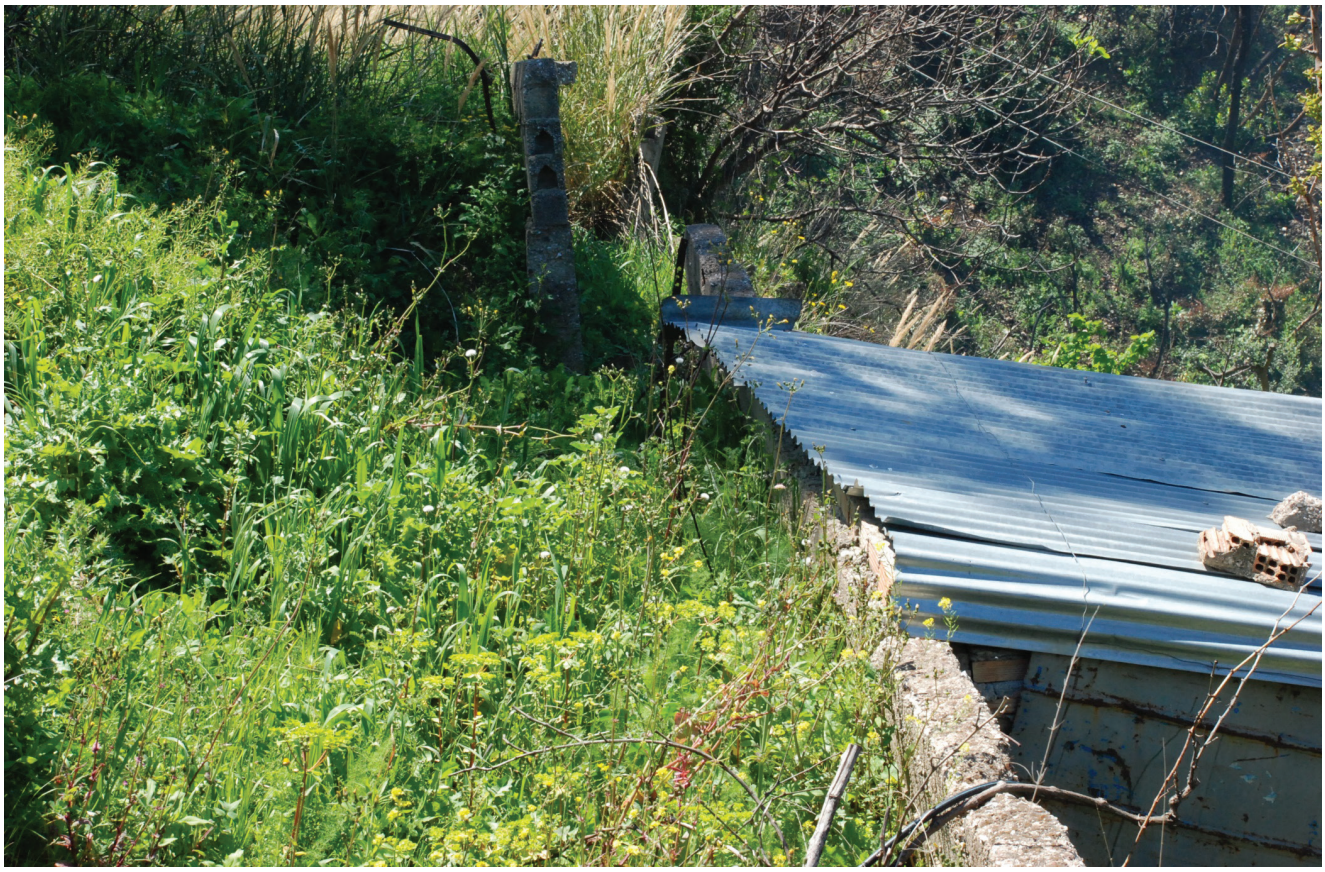


Figure 4(b) – Infrastructure and building problems in broader Rio area due to landslides, coastal erosion and poor development design.

Figure 4 (c) – Infrastructure and building problems in broader Rio area due to landslides, coastal erosion and poor development design.

Figure 4(d) – Infrastructure and building problems in broader Rio area due to landslides, coastal erosion and poor development design.

Conclusions

The construction of general infrastructures such as roads, homes, shops, and ports completely replace natural habitats with manmade structures. Alluvial fans, deltas and their rivers, coasts and beaches are often modified in order to serve the public needs or suffer the consequences of the poor design of any kind of human intervention.

These interventions to the natural environment have to be executed with the help of appropriate planning practices and the raised environmental awareness of the people in charge. The interaction between urban development, risks, hazards, and the environment is complex and often determines the magnitude of the problems to be created.

In our case, the peri-urban and mostly coastal area of the city of Rio, in many cases these practices have not been followed. As a result, these man-made interventions are not in harmony with the natural environment. Many hazards have been created during the development of the area. Public roads (figures 5a-b), the port, residential and public areas, face the results of the dynamic, diverse but also disordered development.

The complete remediation of the already existent problems is in most instances complex and requires a big budget and this is the way in many cases simple maintenance is preferred to a large-scale remediation project.

The decisive point to take into account the results of the human intervention of any kind to the environment is before any construction. It will produce better results with less cost and less disturbance to the population.

This dictates us that a development assessment model regarding the impact of any intervention on the natural environment is of high importance. It will shape the development policy accordingly in each case and help to appropriately remediate the already existent problems.

It will also let us handle in the best way, the increasing trend of conversion of the peri-urban agriculture lands and fields into residential areas and will minimize the risks involved.

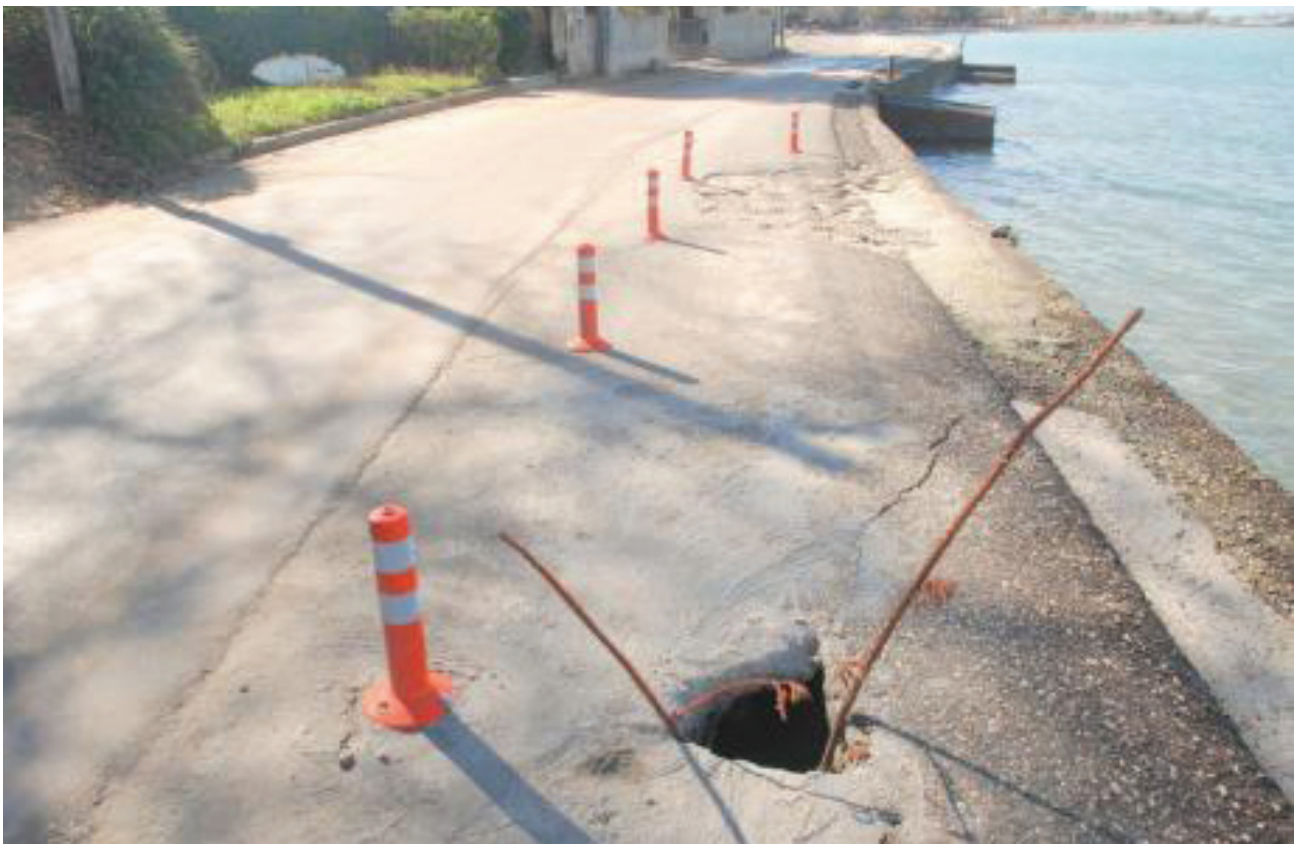


Figure 5(a) – Maintenance and signage is preferred to a large-scale remediation project on the coastal area.

Figure 5(b) – Old sign next to a road build on an active landslide. The road was repaved, but the sign indicates that the landslide is still active.

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