Co-funded by the Erasmus+ Programme of the European Union

GOAL Educational Resource: Georisks

AUTHORS	Nir Orion and Ron Ben-Shalom, Weizmann Institute of Science
TITLE OF THE CASE	Integration of Geoethical aspects of Georisks within field trips of earth sciences academic courses
SHORT CASE DESCRIPTION	One of the Geoethical subjects of the GOAL project is Risks. Aspects of this subject are included in many various academic geoscience courses. For example, introduction to geoscience, tectonics, structural geology, mapping, geomorphology …. Many geoscience courses include field trips as an integral part of the course. This educational resource presents examples of using geoscience field trips to in order to raise geoethical dilemmas of georisks and public knowledge and undertanding.
KEYWORDS	Georisks, earthquakes, sinkholes, the outdoor learning environment, educational resource.
PRIOR KNOWLEDGE	Geoethics, The outdoor learning environment, Georisks, public knowledge.
AIM	Promotion of the integration of geoethical values (ethical, cultural and social) within geoscience academic courses.
OBJECTIVES	- To present concrete examples of field trip activities related to earth science phenomena that appear worldwide. - To present concrete examples of outdoor activities that can easily be modified for teaching in various academic courses in any country. - To present concrete examples of field trip activities that raise ethical, social and cultural dilemmas that appear everywhere. - To boost Geoethical education in schools and in higher education (social values).

CASE	
	Field trips are still a common teaching environment for many geoscience academic courses. Moreover, the outdoor environment enables exposing students to concrete geoethical dilemmas that rise directly from their field observations. However, to fulfil the educational strengths of the outdoor environment, lecturers have to change their teaching method in the field. In the outdoor, they should focus on active learning instead of their lecturing habit. They should use worksheets with instructions and questions that would direct the students to a concrete interaction with the phenomena and not with the lecturer (reference to the ebook). The following are two examples of the suggested method of raising geoethical dilemmas concerning georisks: **Case 1: The Dead Sea hotels and earthquake risk along plates boundaries** – The interaction between earthquakes risks, geoscientists' knowledge and society awareness *Part 1:* The Potassium industry took over the southern shallow basin of the Dead Sea and converted it to evaporation ponds (figure 1).  *Figure 1: Dead Sea Plants Evaporation Ponds at the Southern Dead Sea basin.* Many hotels were built along the shoreline of the biggest pond for the hundreds of thousands of tourist who come for the recreational and medicinal attractions of the Dead Sea (figure 2).

Figure 2: Ein Bokek hotel area, along the shore of the Dead Sea Plants evaporation Pond.

However, following the sedimentation of Halite on the bottom of the evaporation pond, the pond water level keeps rising, resulting in the Dead Sea Plants having to raise the pond's dams every year. The rising water level already reached the foundations and the ground floors of the hotels. To prevent the flooding of their lobbies, the hotels have to pump the water (figure 3). Although the ground floors of the hotels are dry, their foundations are soaked in corrosive Dead Sea water.

Figure 3: Pump pipes (left) and a Pump disguised as a sculpture (right), Dead Sea hotel beach.

Part 2: The Dead Sea is located in a rift valley formed by the Dad Sea transform – an active tectonic plate boundary between the Arabian and African plates. The Lisan formation which is exposed in many marginal terraces in the rift valley, is a sequence of lake sediments that were deposited in Lake Lisan ("tongue" in Arabic) that existed in the last glacial (70–14 ka).
The formation is largely composed of seasonal laminae of Aragonite and clay/marl.

The Lisan Formation contains "dancing varves", which are seismites - seismically disturbed sequences, that are a few centimetres to a few dozen centimeter thick (figure 4).

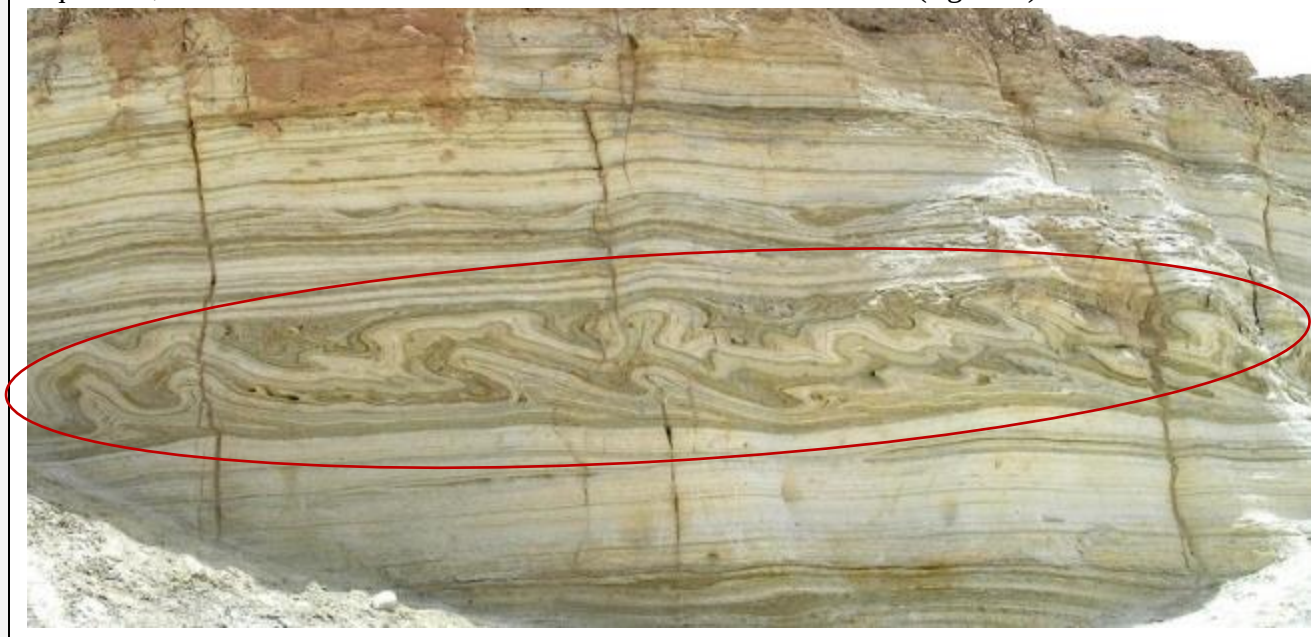

Figure 4: Liasn Formation exposure containing a seismite (red circle)- seismically folded sequence.

The occurrence of these seismites in such recent sediments indicates the possibility of near future seismic activity. The High and rising water level of the industrial ponds and the fact that hotel foundations are already under water poses a serious risk to the public.

Case 2: The sinkholes geomorphological risk – The geoethical earth systems ignorance of the society

The Dead Sea has been shrinking rapidly for the past few decades, due to the diversion of water from the Jordan River (which feeds the Dead Sea) and mineral mining from its waters in the south, as water from the deep Northern basin is pumped into evaporation ponds in the south. As a result, the water's surface is currently receding by more than 1 meter per year. As the salty water recedes, fresh groundwater wells up and dissolves layers of sub-surface rock salt, creating large underground cavities, above which sinkholes form (figure 5,6).

Figure 5: A section of the Jerusalem-Eilat road near Ein-Gedi (Dead Sea shoreline), that was recently abandoned due to opening of sinkholes.

Figure 6: Collapsed road section in one of the sinkholes, Ein-Gedi.

QUESTIONS	. What is the role of geoscientists in updating the society about potential risks? . What would be the impact of informing the public about the potential earthquakes risks on the corrosive foundations of the hotels on the tourism industry in the Dead Sea? . What are the consequences of not informing the Dead Sea hotels visitors about the risk of staying there? . How should geoscientists inform the public? . What could be the implications of not informing the public about the potential extent of sinkholes formation along the Dead-Sea shoreline? . What would be the implications of informing the public about the potential extent of sinkholes formation?
PROCEDURE	**Procedures concerning Georisks** https://goal-erasmus.eu/wp-content/uploads/2020/02/procedure_for_IO4B-GeoRisks_educational_resource.pdf
REFERENCES	Bobrowsky, P., Cronin, V.S., Di Capua, G., Kieffer, S.W., Peppoloni, S. (2017). The Emerging Field of Geoethics. In Gundersen L.C. (Ed.), Scientific Integrity and Ethics with Applications to the Geosciences. Special Publication American Geophysical Union, John Wiley and Sons, Inc. Peppoloni, S., & Di Capua, G. (2016). Geoethics: Ethical, social, and cultural values in geosciences research, practice, and education. In Wessel G. & Greenberg J. (Eds), Geoscience for the Public Good and Global Development: Toward a Sustainable Future. Geological Society of America. Doi:10.1130/2016.2520(03). Peppoloni, S., & Di Capua, G. (2017). Geoethics: ethical, social and cultural implications in geosciences. Annals of Geophysics, 60:1-8. Doi: 10.4401/ag-7473. United Nations (2015). Transforming our World: the 2030 Agenda for Sustainable Development (A/RES/70/1). Retrieved from: https://www.un.org/sustainabledevelopment/development-agenda/ Orion, N. and Hofstein, A. (1994). Factors that influence learning during a scientific field trips in a natural environment. Journal of Research in Science Teaching. 31 (10), 1097-1119. Orion, N. (2003). "The outdoor as a central learning environment in the global science literacy framework: from theory to practice". In Mayer, V. (Ed.), Implementing global science literacy (pp.33-66). Ohio State University Kagan, E., Stein, M. And Marco S. (2018). Integrated Paleoseismic Chronology of the Last Glacial Lake Lisan: From Lake Margin Seismites to Deep-Lake Mass Transport Deposits. Journal of Geophysical Research: Solid Earth. Abelson, M., Yechieli, Y., et al. (2006). Evolution of the Dead Sea sinkholes. GSA SPECIAL PAPERS: New Frontiers in Dead Sea Paleoenvironmental Research. Yizhaq, H., Ish-Shalom, C., et al. (2017). Scale-free distribution of Dead Sea sinkholes: Observations and modelling. Geophysical research letters. 44 (10), Pages 4944-4952. https://www.livescience.com/50379-dead-sea-sinkholes.html