



## Concept of Complex Environmental Monitoring Network – Vardzia Rock Cut City Case Study

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Vardzia represents an unique cultural heritage monument – rock cut city, which unites architectural monument and Natural-Geological complex. Such monuments are particularly vulnerable and their restoration and conservation requires complex approach. It is curved in various layers of volcanic tuffs and covers several hectares of area, with chronologically different segments of construction. This monument, as many similar monuments worldwide, is subjected to slow but permanent process of destruction, expressed in following factors: surface weathering of rock, active tectonics (aseismic displacement along the active faults and earthquakes), interaction between lithologically different rock layers, existence of major cracks and associated complex block structure, surface rainwater runoff and infiltrated ground water, temperature variations, etc. During its lifetime, Vardzia was heavily damaged by Historical Earthquake of 1283 and only partly restored afterwards.

The technological progress together with the increased knowledge about ongoing environmental processes, established the common understanding that the complex monitoring of the environment represents the essential component for resolving such a principal issues, as: Proper management and prevention of natural disasters; Modeling of environmental processes, their short and long term prognosis; Monitoring of macro and micro climate; Safe functioning and preservation of important constructions.

Research Center of Cultural Heritage and Environment of Ilia State University in cooperation with Experts from ISPR, with the funding from the State agency of Cultural Heritage, has developed a concept of Vardzia complex monitoring network. Concept of the network includes: monitoring local meteorological conditions (meteorological station), monitoring microclimate in caves (temperature and humidity in the air and rock), monitoring microtremors and ambient seismic noise in Vardzia (local strong motion network), monitoring displacement and deformation of Vardzia cliff by means of Ground-based SAR (GBSAR) interferometry, continuous photo fixation of ongoing destruction.

Works were started in 2014 from the development of network concept and at the end of year 2015 installation of all major components were accomplished. Special Wi-Fi network was installed, using 5.8 GHz frequency to online connect all the station to the central data center in Tbilisi and the same time avoiding complex network of wires on cultural monument. Acquired Data and network status can be seen online on [Vardzia.IliaUni.edu.ge](http://Vardzia.IliaUni.edu.ge). For the management of considerable data flow special Internet Of Thing (IOT) server was developed. First streams of data are already collected and processing started, initial results already obtained and given in current presentation. It should be outlined that Vardzia complex monitoring network does not represent unitary technical or conceptual solution, but it is a constantly developing model to be farther extended by adding more monitoring points and/or increasing monitored parameters. It is extremely important to test and validate given approach in reality, enabling use of these technologies in the study and conservation projects of other, similar monuments.