Η ΣΥΜΒΟΛΗ ΤΗΣ ΠΛΗΡΟΦΟΡΙΚΗΣ ΣΤΗΝ ΠΡΟΣΤΑΣΙΑ ΤΩΝ ΜΝΗΜΕΙΩΝ ΠΑΓΚΟΣΜΙΑΣ ΠΟΛΙΤΙΣΤΙΚΗΣ ΚΑΙ ΦΥΣΙΚΗΣ ΚΛΗΡΟΝΟΜΙΑΣ – Η ΠΕΡΙΠΤΩΣΗ ΤΩΝ ΑΡΧΑΙΩΝ ΦΙΛΙΠΠΩΝ, ΕΛΛΑΔΑ

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Prof. Dimitrios Emmanouloudis

NEED FOR PROTECTION

Natural ~ man-made disasters ~ industrial accidents

increasingly occur on the Planet

Often with hundreds of human victims & devastating consequences

Affecting:

- urban centers
- outdoor settlements
- infrastructures
- monuments of nature and cultural monuments and sites

included in UNESCO World Heritage List

NEED FOR PROTECTION

Especially the second category of the monuments - sites: those of **Culture**

- centennial or even millennial existence
- much bigger structural vulnerability

are at risk of extinction

even after of a natural or human-induced disaster of ***moderate intensity***

MANUAL GUIDE

The issue of *dangers to the World Heritage sites* from natural and human-induced factors

has concerned UNESCO

in particular the World Heritage Center for several years

a **multi-page manual guide** was drawn with the help of experts

natural disasters, special characteristics, effects on cultural sites and humans

are mentioned and listed.

MANUAL GUIDE

In manual guide ~ accompanying technical reports

certain techniques and methods of protecting, management and treatment

of these phenomena are provided briefly and with examples

a fact extremely useful for the Management of these areas

<u>However</u>

even to this day, these methods are mainly based on:

- traditional techniques,
- historical information,
- dubious measurements, etc.

PURPOSE

The **purpose** of this work is to **enrich** the methods and techniques proposed in UNESCO booklets that have been implemented by the World Heritage Center which as it has been mentioned are extremely useful tools

with **methods** and **techniques**

that arise with the help of **Information Technologies** (IT)

AR o VR o AI o IoT

AUGMENT REALITY & VIRTUAL REALITY

The following cases are some approaches

implemented by AETMA Lab of IHU in cooperation with UNESCO Con- E -Ect

in order to educate, demonstrate or raise awareness

among students or general population for World Heritage areas…

Advanced Educational Technologies & Mobile Applications Lab

VIRTUAL SCHOOL

Objectives

- Use of Augmented and Mixed Reality experiences
- Raise Students awareness on Natural Disaster Management
- Make use of high end technology to achieve the goals
- Make technology free for Schools

This project allowed students to design their own school models, helping them to understand better how they should react at a potential threat, such as an earthquake.

VIRTUAL SCHOOL

Recognizing good practices to deal with

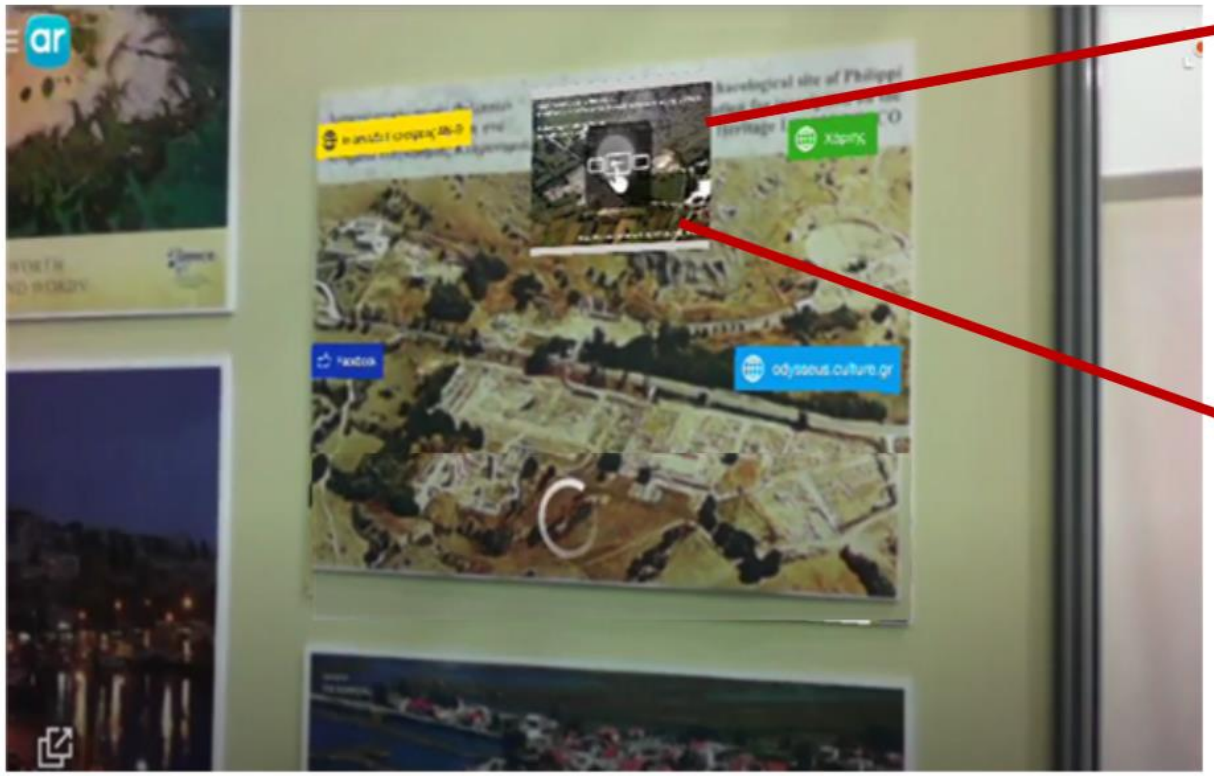
- Natural Disasters
- the use of 3 Digit Numbers

This Virtual application led us to think about using it for museums and archaeological sites starting from the area of Philippi

Using a 3D model of School Environment

AUGMENT REALITY

Ancient Philippi AR tour Kavala Helexpo 2014

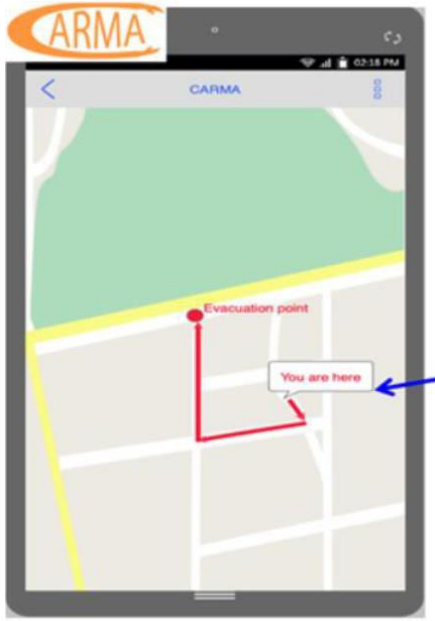


Indeed it was used.
A VR application was implemented for Ancient Philippi

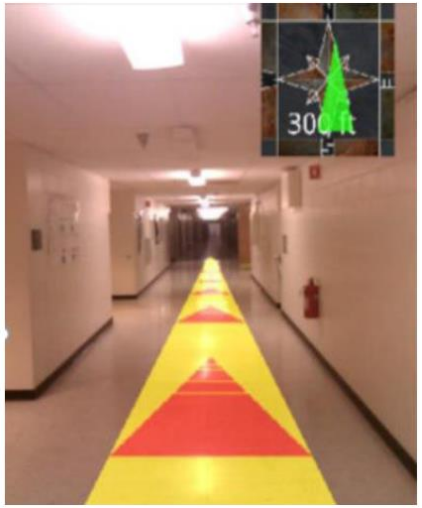
AUGMENT REALITY

CARMA approach

The use of AR in order to inform visitors of a Museum or of an open space, for their location and optimum exploration paths, or evacuation plans



The information on the screen will be specific to the user's location. For example, after scanning a trigger image the **evacuation plan** will appear

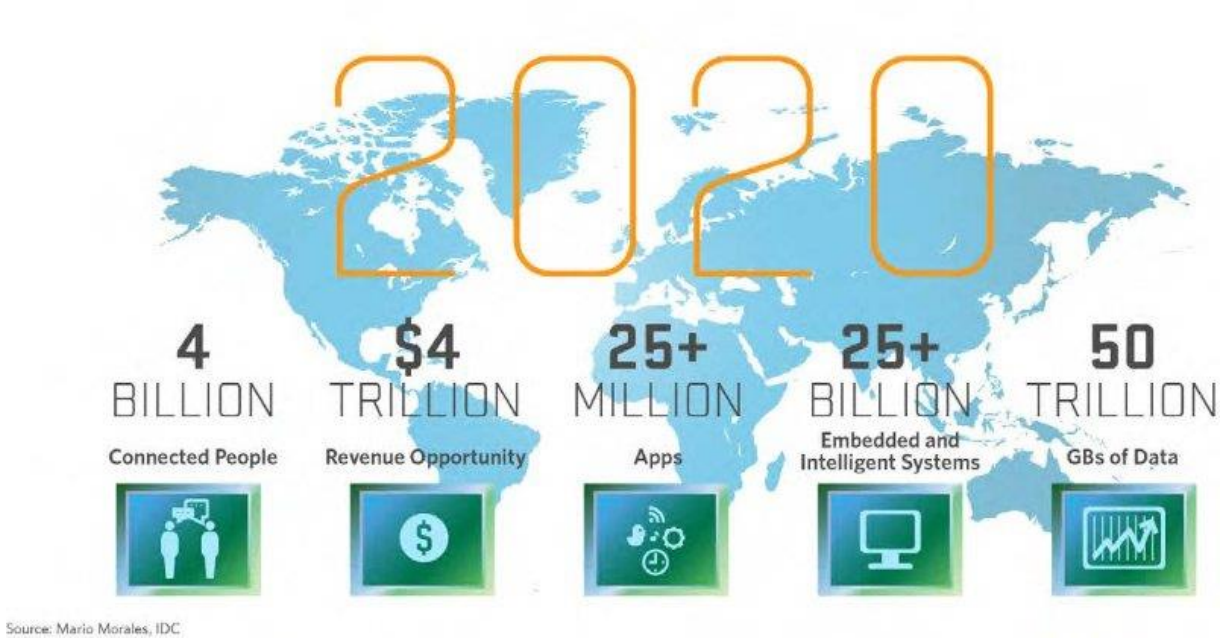


IOT AND MOTIVATION

Growth of the Internet of Things & its **potential to change our daily life**

- ❑ A world (still at an early stage) where everyone and everything, called **Things,** will be connected
- ❑ An open and distributed network
- ❑ Enormous heterogeneity of things
- ❑Things able to make decisions and communicate

– – – → **intelligence | trustworthiness**



IOT AND MOTIVATION

IoT relevant technology is still evolving

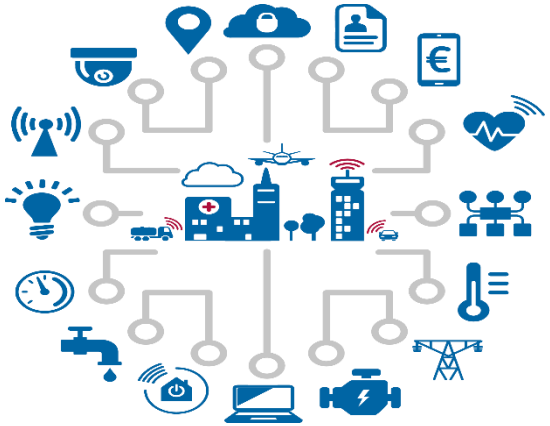
Today, the IoT mostly sends data up towards the Cloud for processing

In the IoT of tomorrow as software and hardware continues to evolve

some processes may be bring back to the devices

value between devices and across industries could be uncovered using technologies such as Intelligent Agents (IAs)

add autonomy, context awareness, intelligence



IOT AND WORLD HERITAGE SITES

UNESCO classifications reveal relationships of hazards

IoT could deal with various challenges based on these categories

All-in-all approach could also be possible though it would be a large-scale case

IoT technologies can't stop disasters from happening, but can be very useful for disaster **preparedness** (prediction and early warning systems) and **response** (organize response and recovery)

Table 1. *Relationships of natural hazards and human-induced hazards*

	Natural	Human-induced	Indirect / secondary
Meteorological	Hurricane Lightning Heavy precipitation		Flooding (coastal / rivers) Fire Mass movement
Hydrological (caused by high rainfall)	Flash flood Landslide / volcanic ash / lava / ice damming of a river Tsunami	Hydrological infra-structure failure (dams, levees, reservoirs, drainage systems) Coastal protection failure (sea walls)	Disease epidemic Pollution
Volcanic	Lava flows Pyroclastic flows Ash and block falls Gases	Mining-induced (e.g. mud volcano)	Lahars (mudflows) Landslides Tsunami Fire
Seismic	Faulting Transient shaking Permanent deformation (e.g. folds) Induced movement (liquefaction and mass movement)	Dam- and reservoir-induced mass movement Mining-induced Explosion / nuclear induced	Mass movement Fire Flood
Mass movement (of snow, ice, rock, soil mud, etc.) (induced by slow-acting erosion or one of the above)	Falls Slumps Slides Flows	Unstable mining / construction waste spoil heaps	

IOT AND WORLD HERITAGE SITES
METEOROLOGICAL - HYDROLOGICAL HAZARDS

Need for **Monitoring and Management**

✓**Smart devices** and **applications** from daily life could be used

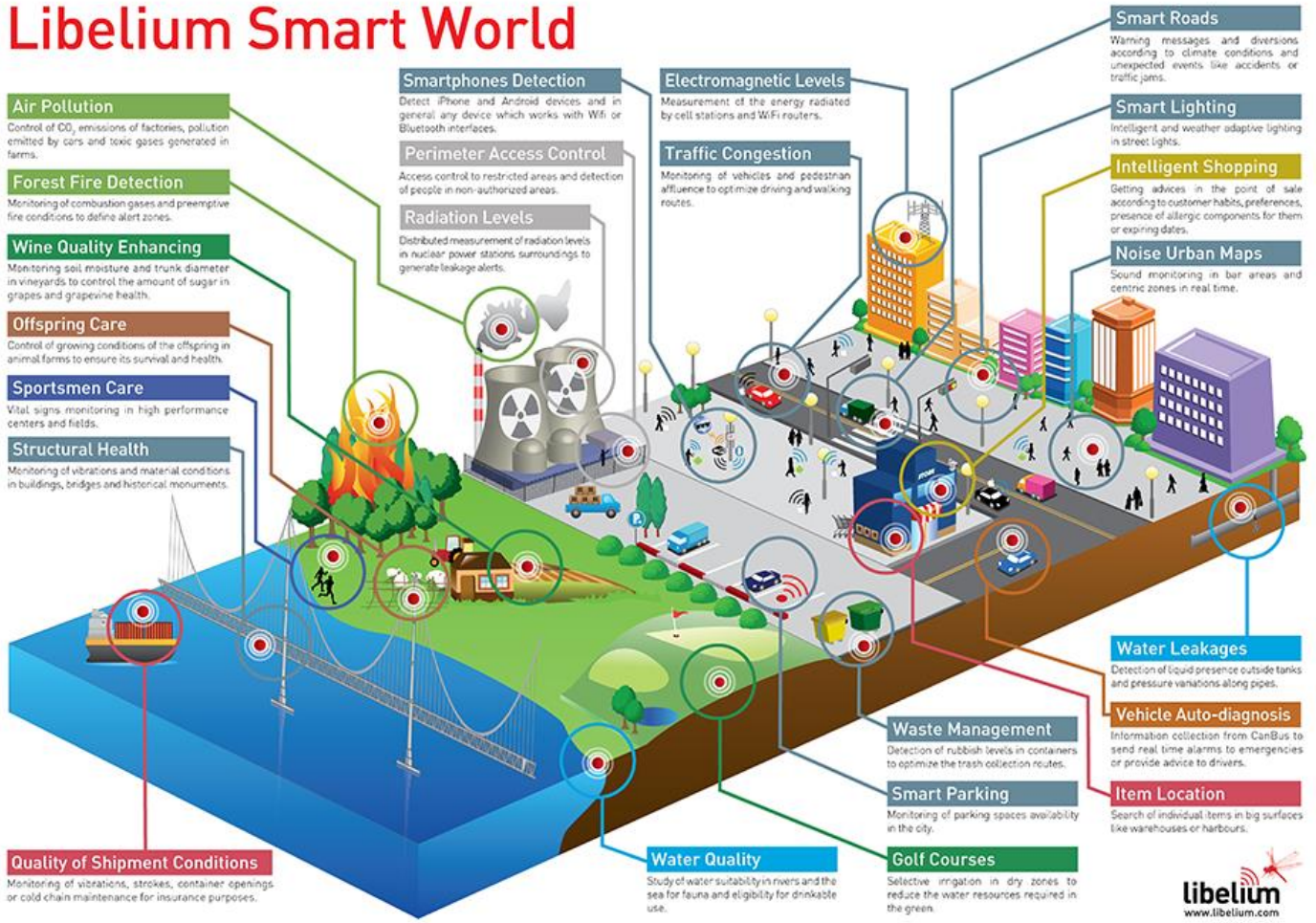
✓Synergy of **GIS** and **IoT** for **Weather Disasters**

Data measured and collected by distributed sensors (in different locations)

The system generates alerts

Dissemination in near real-time to responsible entities and the public

Multiple dissemination mechanisms



IOT AND WORLD HERITAGE SITES
METEOROLOGICAL - HYDROLOGICAL HAZARDS

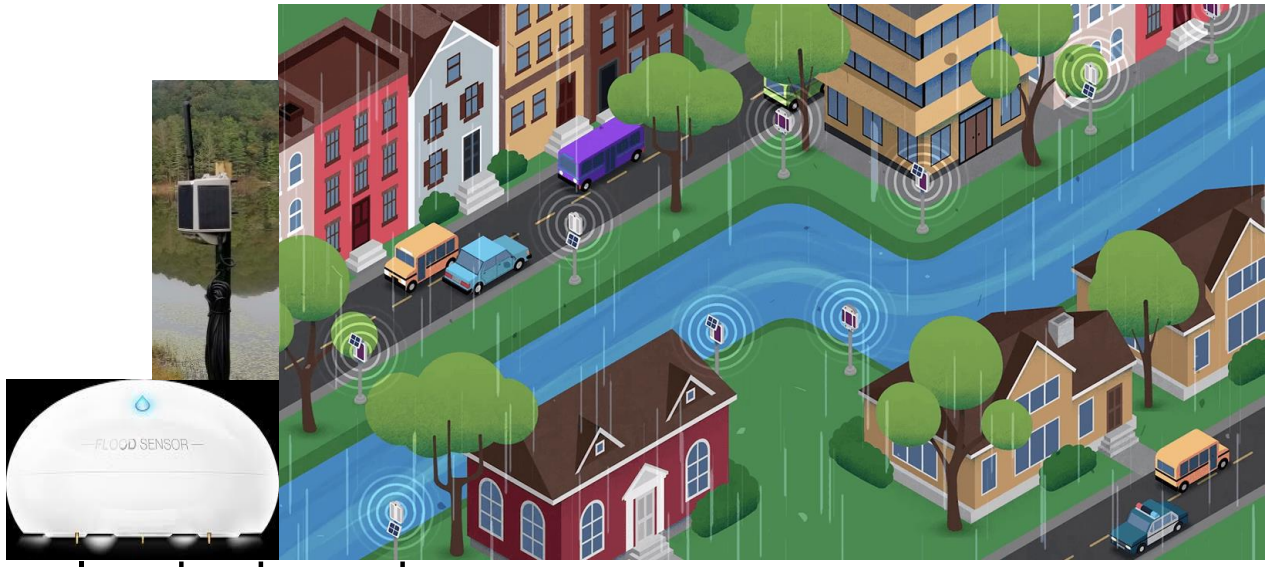
Natural weather events: hurricanes, forest fires, floods, volcanoes, tornadoes and earthquakes

Usually, IoT (sensors) monitors natural weather events and notify about critical safety information

Sensor technology offers real-time information during and after a natural weather event occurs

For example, sensors are capable of monitoring:

- detect increased water levels before a hurricane
- track how quickly a forest fire is spreading



We have to go beyond that:

Use IoT to forecast **but also deal with issues** related to hazards

Flood Sensors

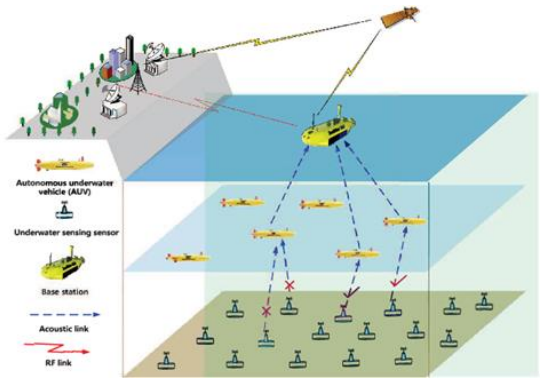
IOT AND WORLD HERITAGE SITES
HYDROLOGICAL HAZARDS – COASTAL PROTECTION FAILURE

Pollution affect harbor sea water and entire area ecosystem

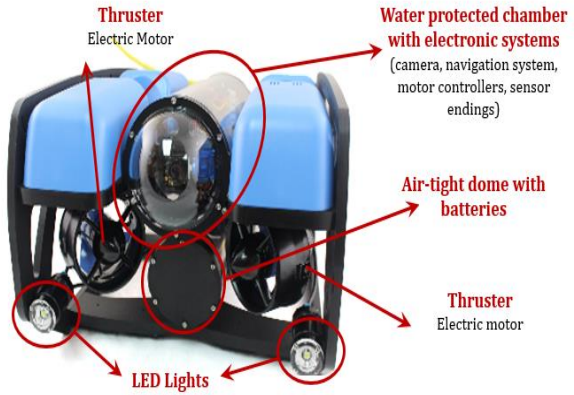
- extremely important a constant and reliable monitoring of the (sea) waters

<u>Monitoring and Warning systems:</u>

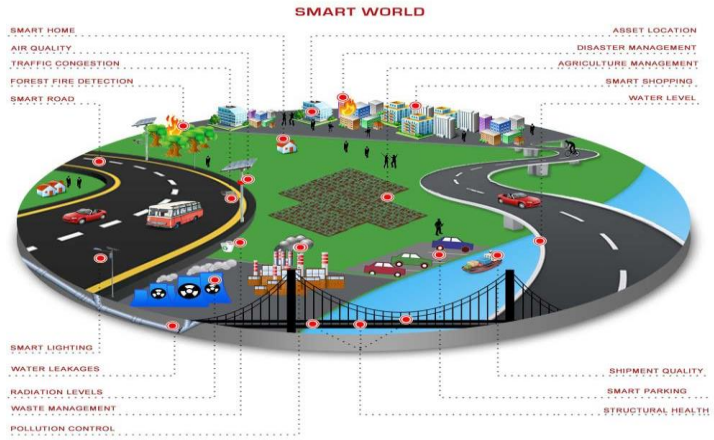
- a light-weighted ROUV (Remotely Operated Underwater Vehicle) equipped with a complete set of sensors in order to collect data and samples (engineering)
- a novel smart monitoring platform that will enable autonomous decision making/suggestion (Artificial Intelligence)



This vehicle has been developed at the laboratory of Electric Vehicles and Automotive Electronics of the Department of Industrial Engineering and Management at the International Hellenic University



IOT AND WORLD HERITAGE SITES
METEOROLOGICAL - HYDROLOGICAL HAZARDS



IoT : predict natural disasters?

<u>Early warning systems:</u>

- **Risk knowledge:** categorical system of hazard analysis
  - officials prioritize local response efforts and manage their resources (smart automation a step further!)
- **Monitoring:** hazard identified, up-to-date environmental track changes in order to reflect the severity and expected outcome of the natural disaster
- **Warning communication:** multi-channel communication protocols
- **Response capability:** Information alone cannot assure a positive outcome (we need more!)

IOT AND WORLD HERITAGE SITES
VOLCANIC – SEISMIC HAZARDS – MASS MOVEMENT

IoT : Earthquakes and volcanic eruptions

Based on low-power wide-area network (LPWAN) approaches

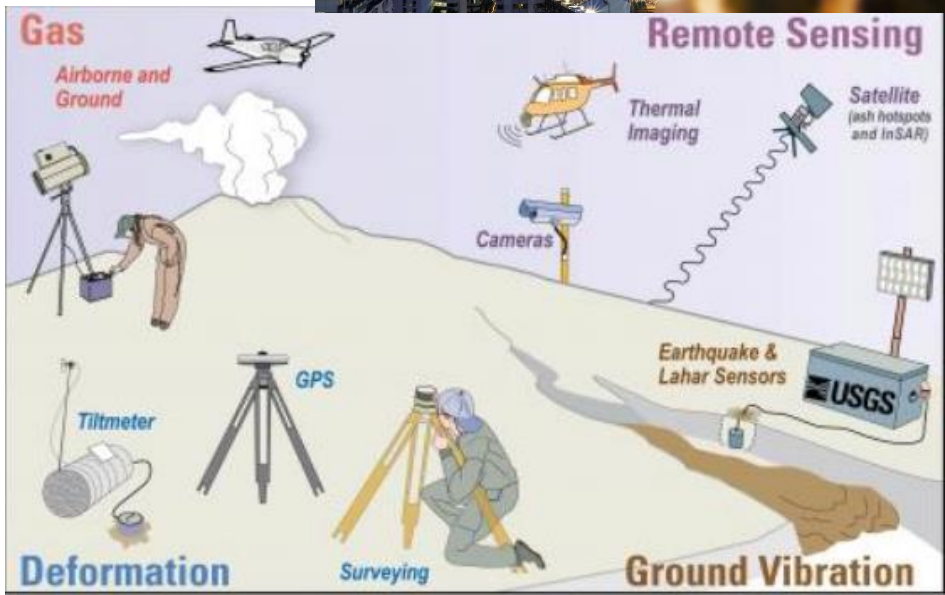
- providing low power
- low data-rate communication over long distances
- enabling battery-operated devices to operate for long time periods

Measuring mainly:

physical and chemical changes

increases in seismicity, gas emissions, surface deformation etc

these signals can help to identify any deviation from the background volcanic activity, making it possible to forecast where and when an eruption could take place



PROPOSAL

Our proposal aims at a novel INDEX and IT Booklet combination that will enable a holistic approach

The proposed INDEX is something different from ICOMOS – GOOGLE platform

where five Heritage Sites presented and

their Risks and Dangers are measured, monitored and analyzed

The proposed by us INDEX is much more **broader** with a **Universal character**

aiming to include **all monuments**

but of course due to the huge information size, with a brief format

PROPOSAL

In this effort

there will be aid from local Nationwide committees of each country

whose Monuments shall be included in this Index

These committees will co assist the work of the Scientific Experts of the Chairs

by providing information and measurements available to each of these countries

regarding the dangers and the corresponding sites

All the above are in absolute accordance with guidelines of “Policy document on the impacts of Climate Change on World Heritage properties”, after the relevant consultation on January 2020.

PROPOSAL

In a second Booklet

specific guidelines for the protection of the Monuments and the Visitors on a **global level**

based on the **New Technologies** could be provided

Such guidelines were presented beforehand

and referred to the classification of the previously mentioned Index

so for each Monument the instructions would **focus on the handling** of the specific threat(s)

which are more **possible to occur**

PROPOSAL

A pilot study could commence from our country for the 15 Cultural Sites

(since only recently a full and complete Structural Integrity study on the Acropolis was submitted by KEMEA)

and for the 2 ones of Mixed Interest

This proposal seems to appear similarities with the LIFE – IP project, that has been announced two years ago by Ministry of Environment, but in fact is different

In Life – IP project five of the total 18 Greek Heritage sites investigated and only in relevance with the factors that affect Climate Change

The Chairs of the UNESCO in Greece could fully meet the demands of such a challenge

ANCIENT CITY OF PHILIPPI – PILOT STUDY

The **Ancient City of Philippi** is the 16th and chronologically speaking the last

Monument of Greece that was included in this list of UNESCO

In our opinion, this monument is significantly endangered:

neither by common natural disasters e.g. fire, flood (from Flash Floods), earthquake etc.

nor by atmospheric pollution or other major pollutants.

However, **it is at risk**

because of a particular phenomenon of

the **flooding of the Marshlands of Philippi**

which are located both all around and just a few hundred meters away

ANCIENT CITY OF PHILIPPI

This **flooding is periodical** (every winter)

while during the summer there is a total drought of the marshlands.

The phenomenon of the constant rising and lowering of the surface water body for ongoing years with a particular increasing rate during the last decades

↓

is quite possible to lead to the activation of the subsurface soil water table circumferentially the Ancient Town

↓

thus to peril of the overall Geostationary Balance of the area

with innumerous repercussions for the Ancient Settlement

ANCIENT CITY OF PHILIPPI

Consequently, all-year-round are essential thorough measurements of

- several soil and climate parameters
- soil and subsoil detailed factors

The **development** of these measurements and their progress determines

- the existence - or its lack - of a direct danger
- the course of the works for protection
- even the way visitors may affect the area

especially when there is a load of 5,000-6,000 people with vehicles nearby

(Ancient Theater Performances)

THREATS

Philippi Case study leads to the obvious as well as useful inference that

all the natural and human-induced dangers **do not appear in the same extent** of threat

for every UNESCO Natural or Cultural Monument

So, in our case, the **Ancient Town**

does not seem to be threatened by an extended forest fire or air pollution

On the contrary, **Ancient Olympia**

is clearly threatened by an extended and uncontrollable Forest Fire

While the **Acropolis in Athens** faces problems with air pollution

This variety in threats at each monument, reveals the necessity of the proposed index where the risks will be classified and prioritized, customizing the protection actions

PROPOSAL

3 step INDEX proposal!

1st: Study the monument - site

2nd: Augment Reality / Virtual Reality (AR/VR)

3rd: Artificial Intelligence / Internet of Things (AI/IoT)

Case study:

Ancient City of Philippi

Ancient City of Philippi

PROPOSAL

1a. Characteristics of site e.g. marshlands

2b. Potential types of hazards e.g. flooding

1. **Study the monument** (Ancient City of Philippi)

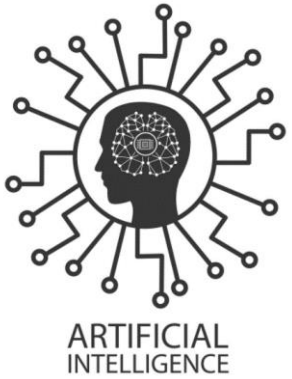
2a. Demonstrate risky locations etc

2b. Provide awareness to public/visitors/etc

2c. Provide guidelines e.g. evacuation of site

2. Reproduce site using **Augment Reality**

BOOKLET

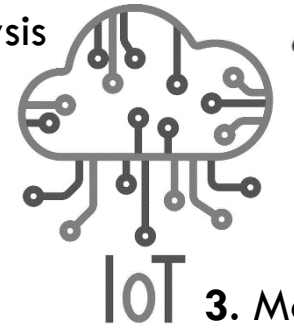


3a. IoT Equipment e.g. sensors, etc

3b. Collecting and **reasoning** on data

3c. Smart real time control application

3d. AI techniques for stakeholders

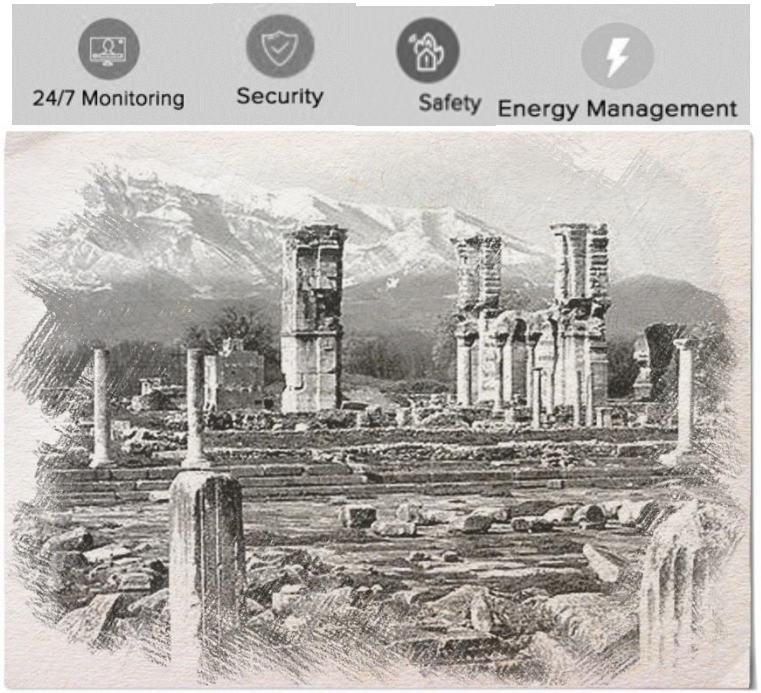


3. Monitor and manage site using **Internet of Things** **&** support collaboration and response via **Artificial Intelligence**

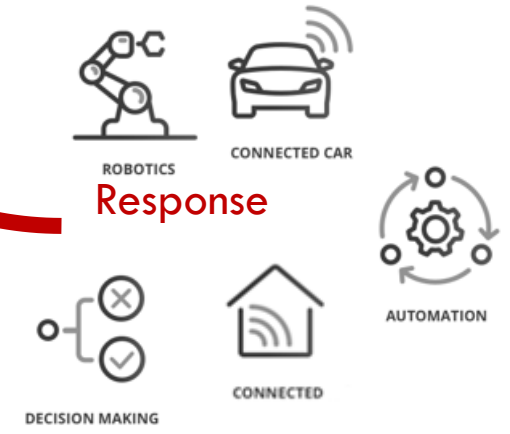
- ✓Hazard Analysis
- ✓Risk Analysis
- ✓Preparedness
- ✓Response
- ✓Recovery

INDEX (Risk Levels)
Smart real time system

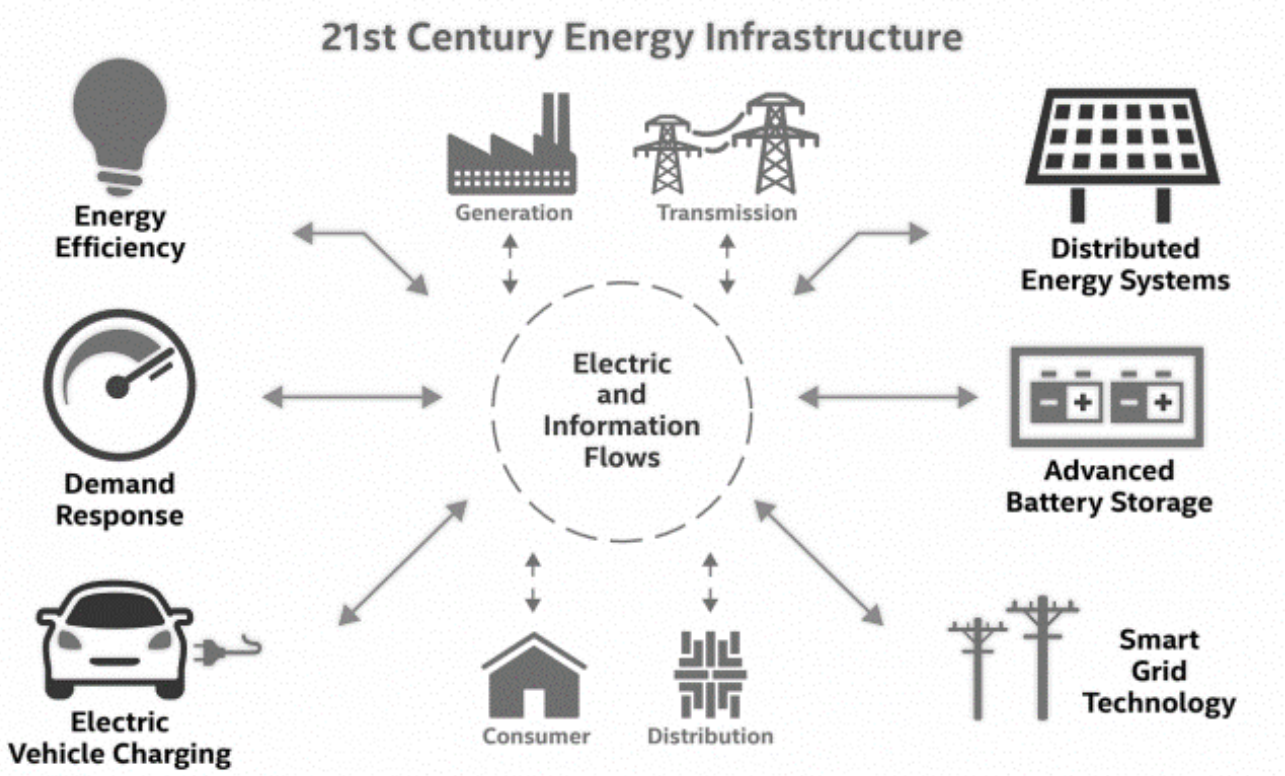
PROPOSAL



AI / IoT for Smart Monuments/Sites



PROPOSAL



Scenario snapshot including energy management:

i. One night the Risk Analysis module upgrades Risk to level 3 (Orange)

ii. The Preparedness module monitors the situation analysing incoming data, proposes possible response scenarios (e.g. demands vehicle charging at night in order to be ready by sending automating request to vehicles & charging station/building)

iii. Later that night the Risk level is upgraded to 4 (Red – Alarm)

iv. The Response module supports the decision making, proceeds with automated actions, supports stakeholders (e.g. fire station etc)

INDEX RISK LEVELS:

Green (level 1) | Yellow (level 2) | Orange (level 3) | Red (level 4)