

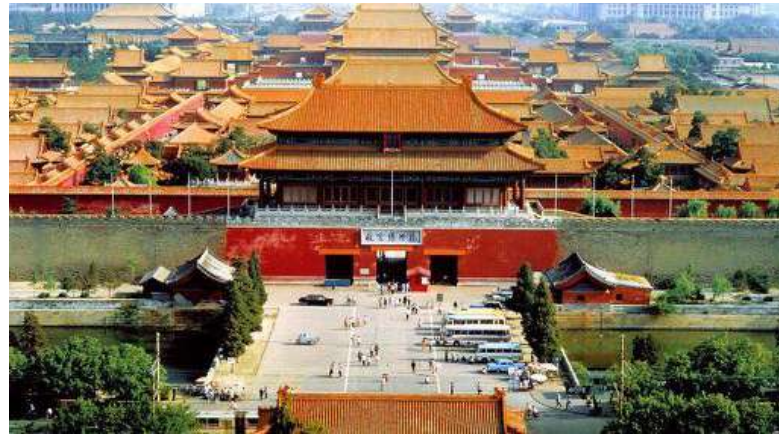


Application of Geospatial Information Technology in the Sustainable Development of Cultural Heritage

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1 Backgrounds

The existence of all cultural heritages are facing the challenge of sustainable development.



- Wenchuan Earthquake: A large number of cultural heritage including the **Dujiangyan ancient buildings** have been severely damaged, and the restoration funds need more than **6 billion**, at least **5** years.
- Global Foundation: **142** sites destroyed and disappeared in the **400** sites excavated in 2000-2009.
- The third national cultural relics survey: more than **30,000** registered cultural relics disappeared.

1 Backgrounds——Cultural heritage



◆ Cultural heritage definition : Tangible and intangible

“Tangible cultural heritage” Including historical relics, historical buildings, and human cultural sites.



1 Backgrounds——Cultural heritage



◆ Cultural heritage definition

“ Intangible cultural heritage ” Various practices, performances, expressions, knowledge and skills and related tools, objects, crafts and cultural venues.



1 Backgrounds——Realistic threat



◆ Cultural heritage faces the great threats of destruction



① Bamiyan Buddha was blown up

② Dujiangyan Erwangmiao Wenchuan earthquake damage

③ Thousand hands painted layer erosion

④ Ying County Wooden Pagoda structural damage

1 Backgrounds——UN sustainable development goals

SDGs:

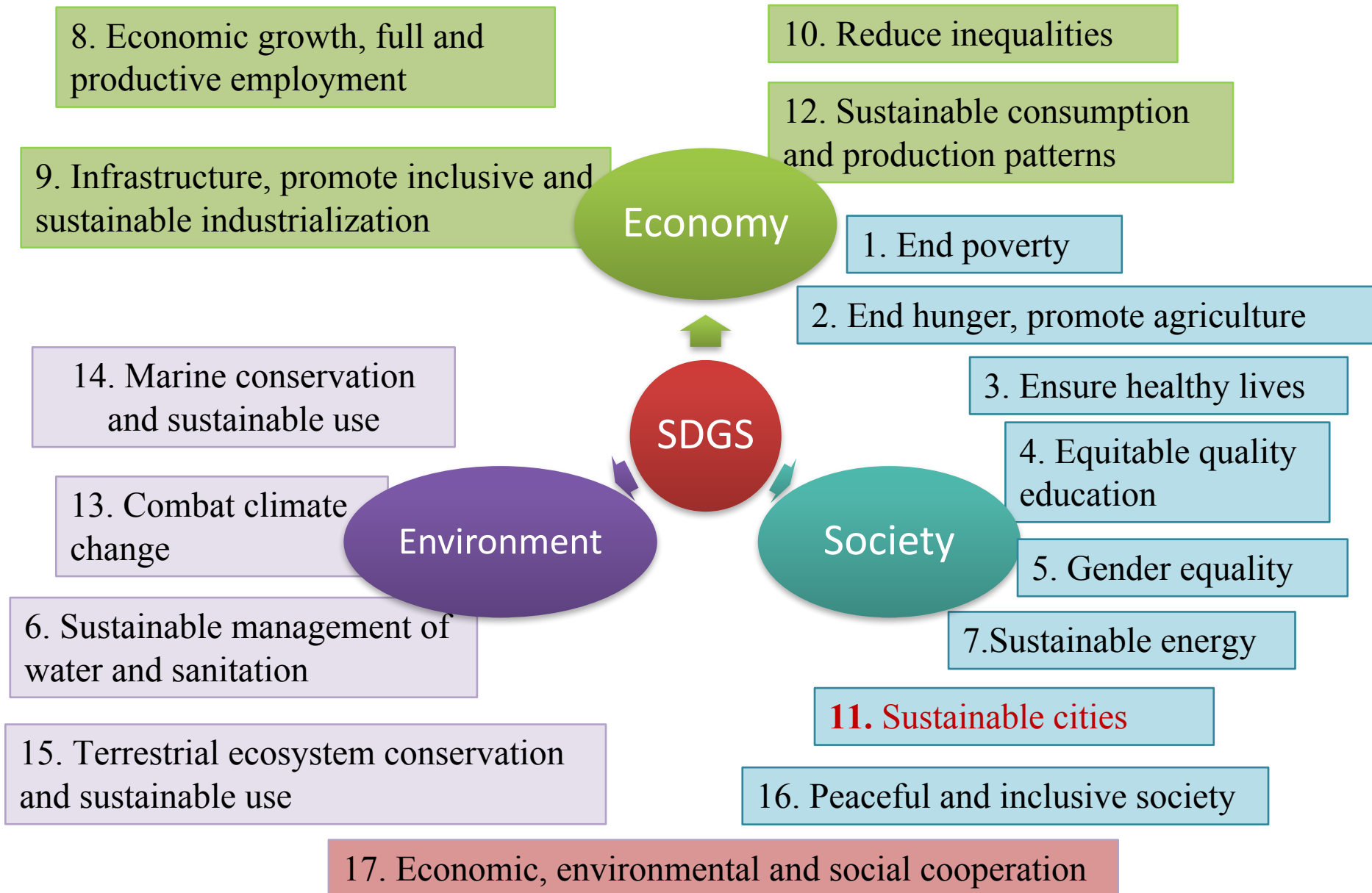
In **1982**, Rio, Brazil proposed the concept of sustainable development .

In **2012**, world leaders gathered to set new Sustainable Development Goals

In **2015**, the “2030 Agenda for Sustainable Development” adopted by 193 member states of the UN General Assembly



1 Backgrounds — UN sustainable development goals



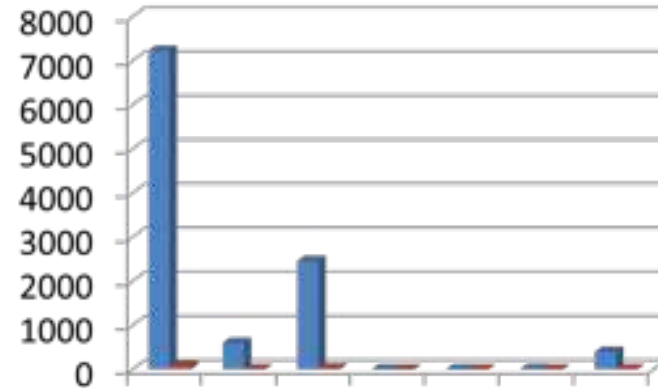
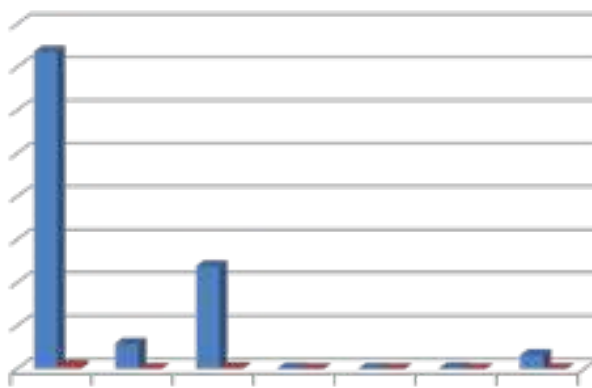
◆ Sustainable conservation concept of cultural heritage



Positioning of Yingxian Wooden

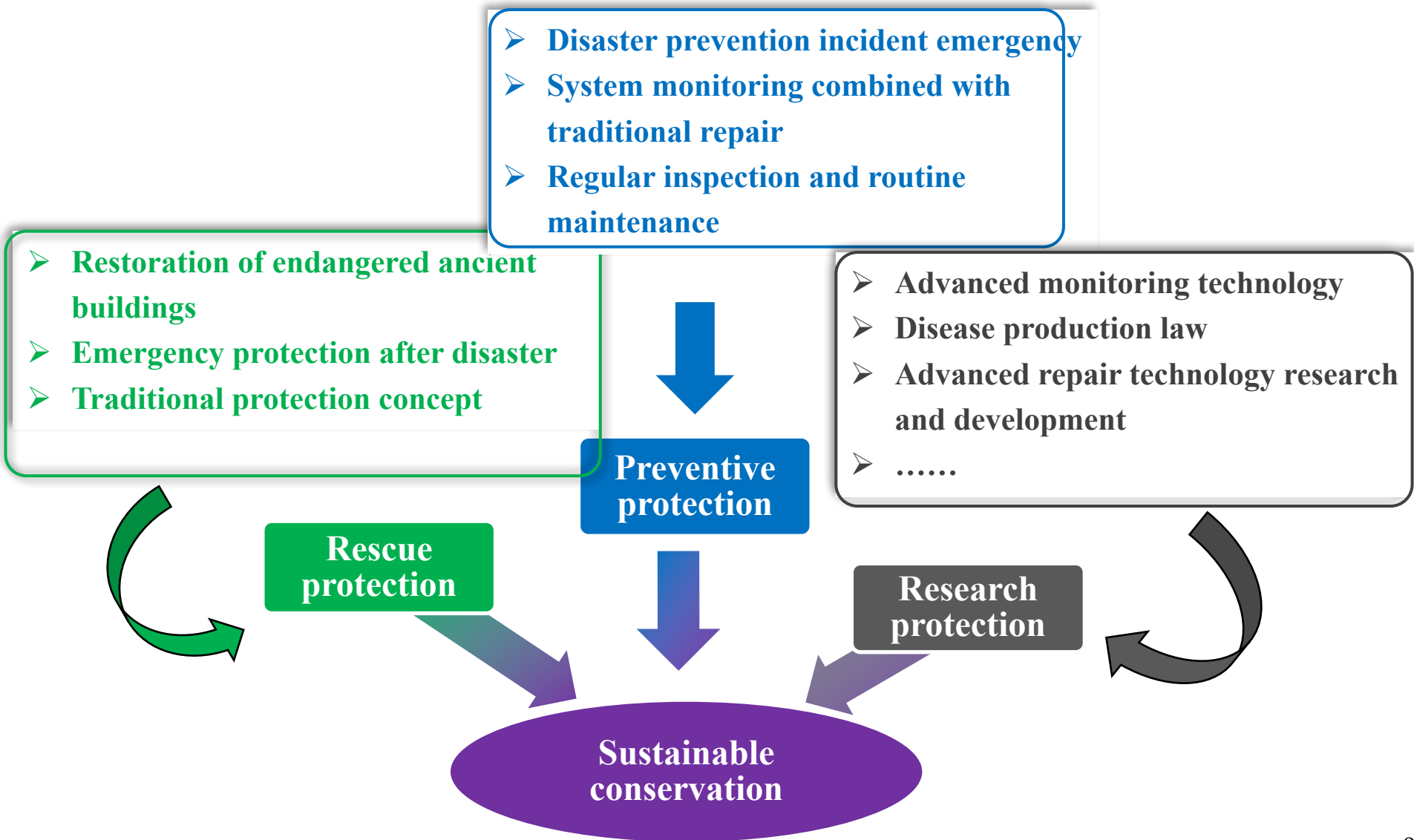


Positioning of the Potala Palace



Although cultural heritage cannot be immortal, the sustainable protection and development of cultural heritage can be realized by

Sustainable conservation of cultural heritage



2 Sustainable Development of Cultural Heritage

Limitations of SDGs indicators for cultural heritage

**spatial
description**

**protection of
cultural heritage**

**description of the
degree of
digitization**

**disaster prevention
and mitigation
indicators**

**SGDs11.4
economical index**

**Lack of financial
investment**

**Core area of the
heritage site**

Nipper earthquake

**Spatial
distribution type**

Flow of funds

**Heritage area
buffer area**

**Brazilian Museum
Fire**

**Spatial structure
type**

**Land type change
evolution information**

**Heritage boundary
line**

Nine-storey temple

**Cultural heritage
circle**

.....

heritage area

Heavy rain

2 Sustainable Development of Cultural Heritage

Demand for sustainable development and protection

Acquisition and preservation of current and historical information

High precision digital protection technology



Environment, disease, security threat monitoring

Cultural heritage monitoring technology



Disaster assessment analysis

Disaster prevention and mitigation assessment model



2 Sustainable Development of Cultural Heritage

Sustainable protection needs and implementation strategies

What kind of protection intensity status is currently in the cultural heritage?

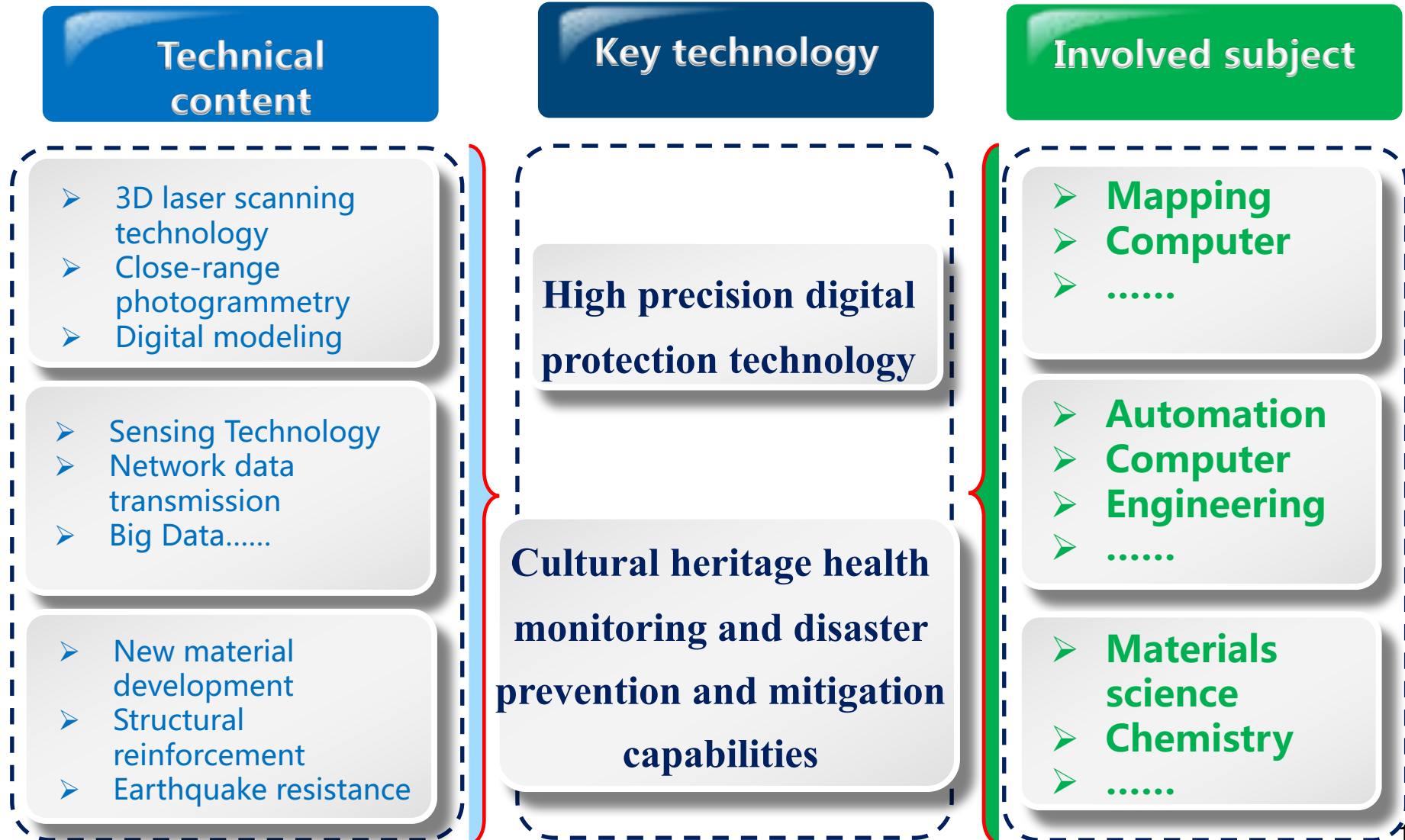
The evolution of disasters in cultural heritage

Improve the cultural heritage's ability to resist disasters

The ultimate demand for the long-term continuation of the historical value of architectural heritage culture

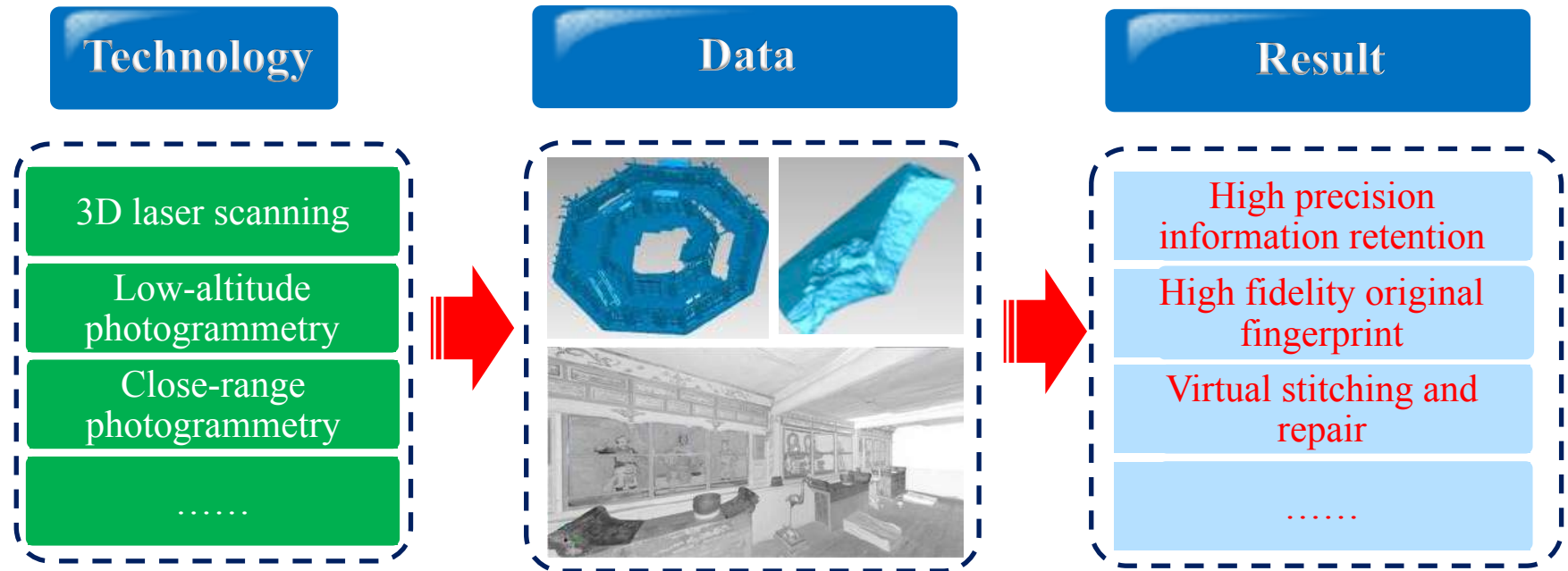
2 Sustainable Development of Cultural Heritage

◆ Technical requirements for sustainable conservation of cultural heritage



2 Sustainable Development of Cultural Heritage

High precision digital protection technology



Limitations and problems

- **The information mining of massive digital data of cultural heritage is not deep enough**
- **However, it has not yet provided a reasonable model for disaster prevention and mitigation capability assessment.**

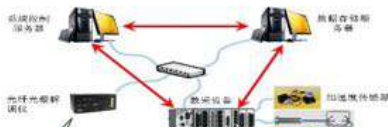
2 Sustainable Development of Cultural Heritage

The status of Cultural Heritage Health Monitoring and Assessment

Technology



Traditional



Monitoring System

Monitoring



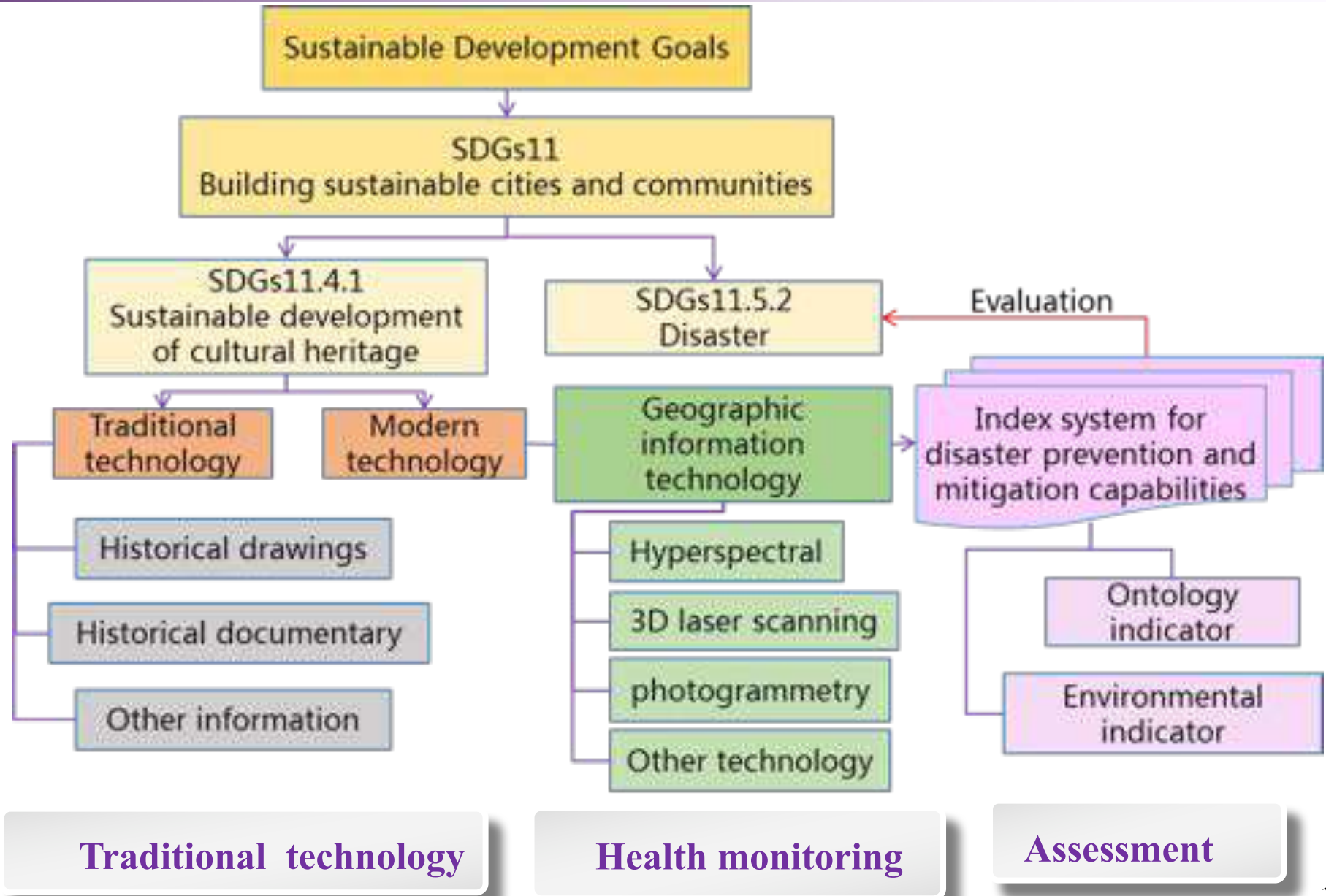
Results

- Accumulated a large amount of monitoring data ;
- Disaster prevention and mitigation capabilities have gradually gained attention.

Limitations and problems

- No health monitoring indicator system has been established yet
- There is no system for disaster prevention and mitigation assessment theory and method

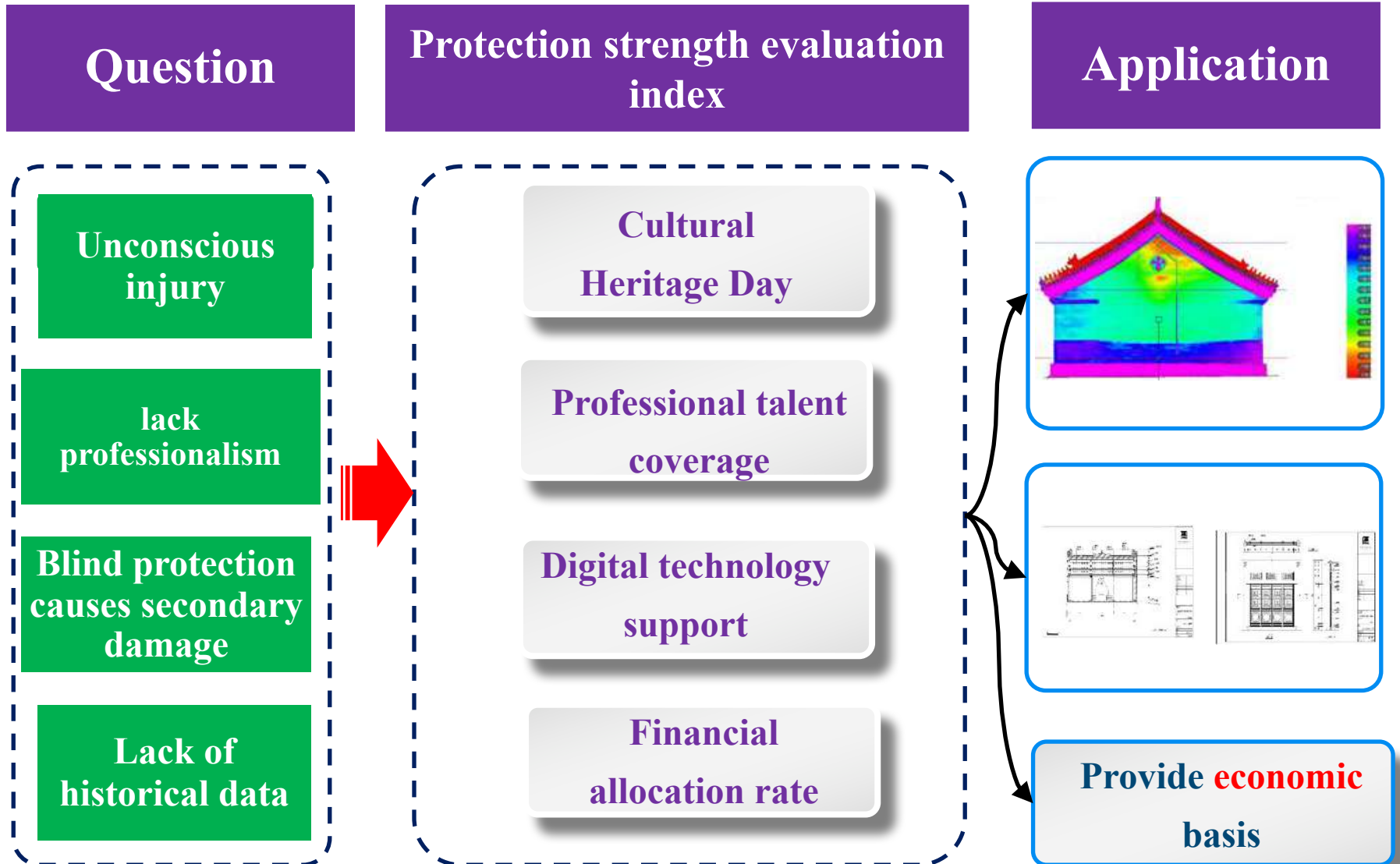
3 New methods



3 New methods (economy)

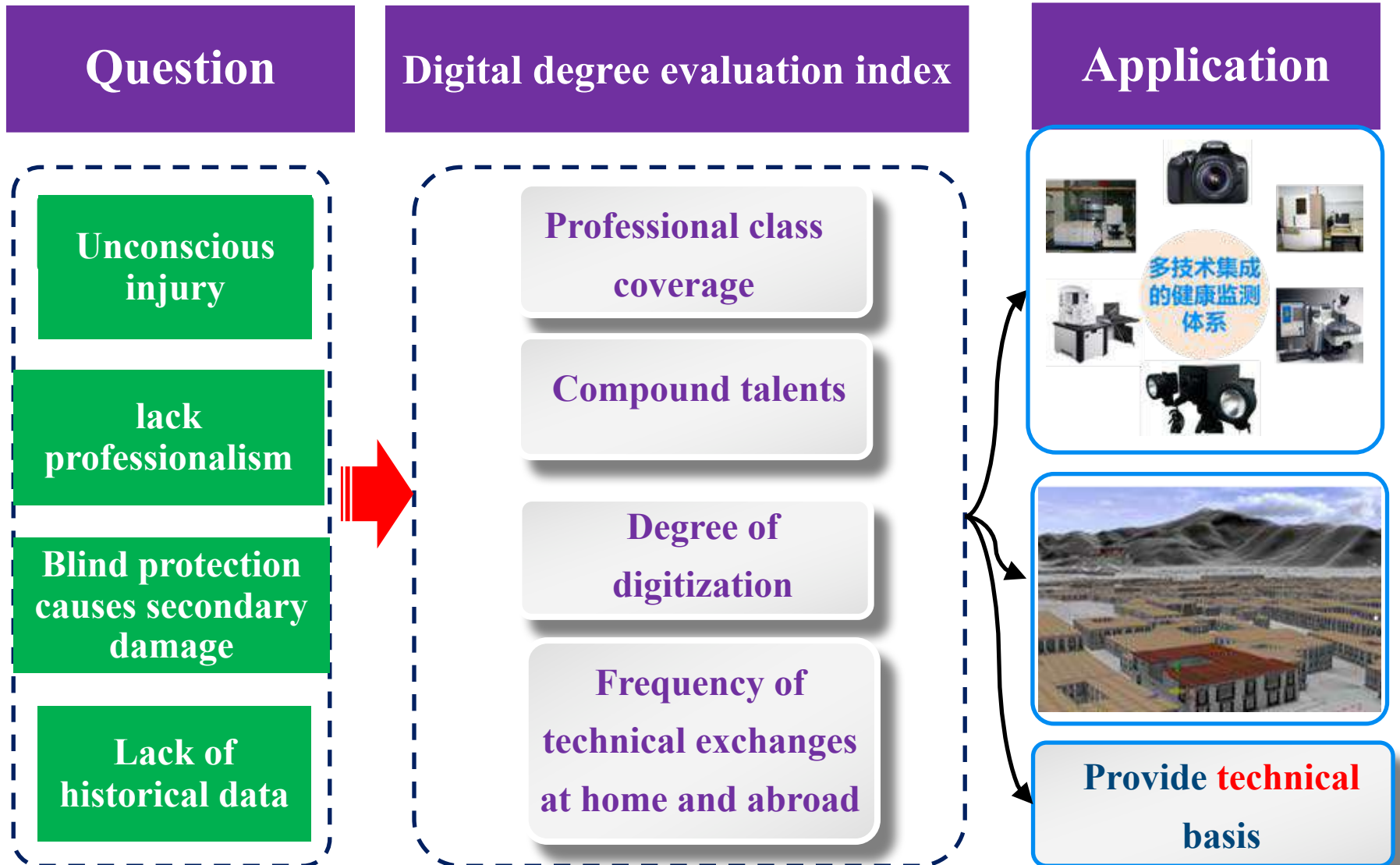


◆ Construction of Evaluation Index System Based on Protection



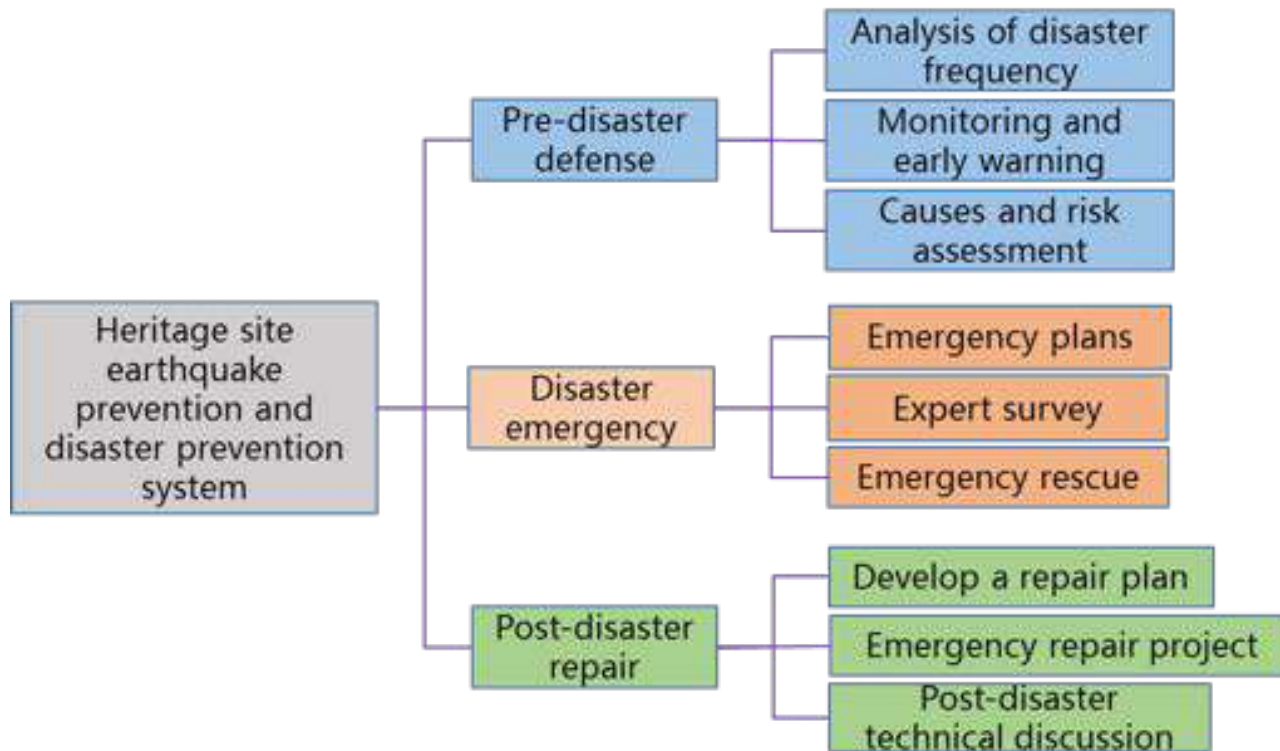
3 New methods (technology)

◆ Construction of Evaluation Index System for Digitalization



3 New methods

- ◆ Construction of Evaluation Index System for Disaster Prevention and Reduction Capability
- **Cultural relics suffered from earthquake damage, destruction of the ontology and living environment, preventive protection, pre-disaster defense, disaster emergency, post-disaster repair, and prevention of further damage.**



◆ Construction of Evaluation Index System for Disaster Prevention and Reduction Capability

From UNESCO:

Definition and method of computation: The percentage of the national (or municipal) budget provided for maintaining and preserving cultural and natural heritage. This indicator represents the share of national (or municipal) budget which is dedicated to the safeguarding, protection of national cultural natural heritage including World Heritage sites.

$$BH_i = \frac{b_{h,i}}{B_i}$$

BH_i = Percentage of annual budget provided for maintaining cultural and natural heritage in the year i

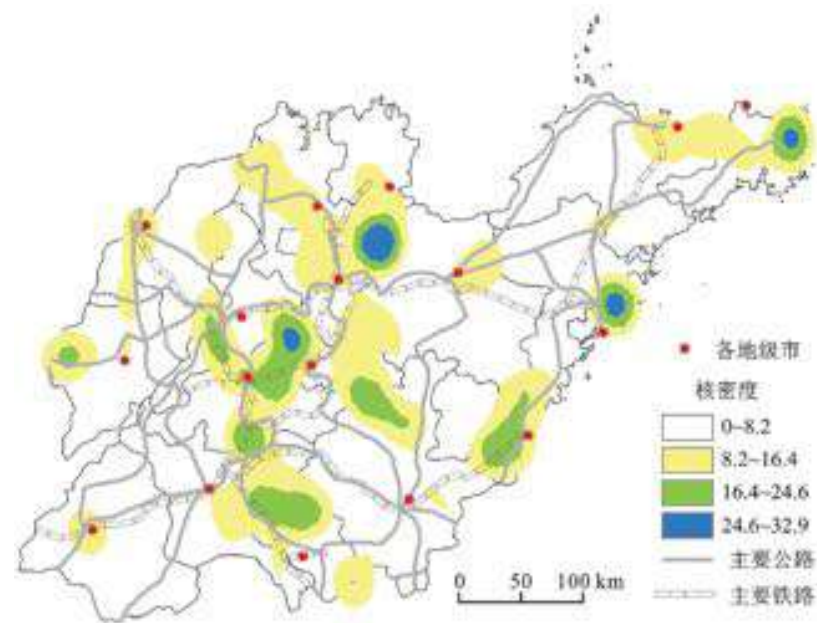
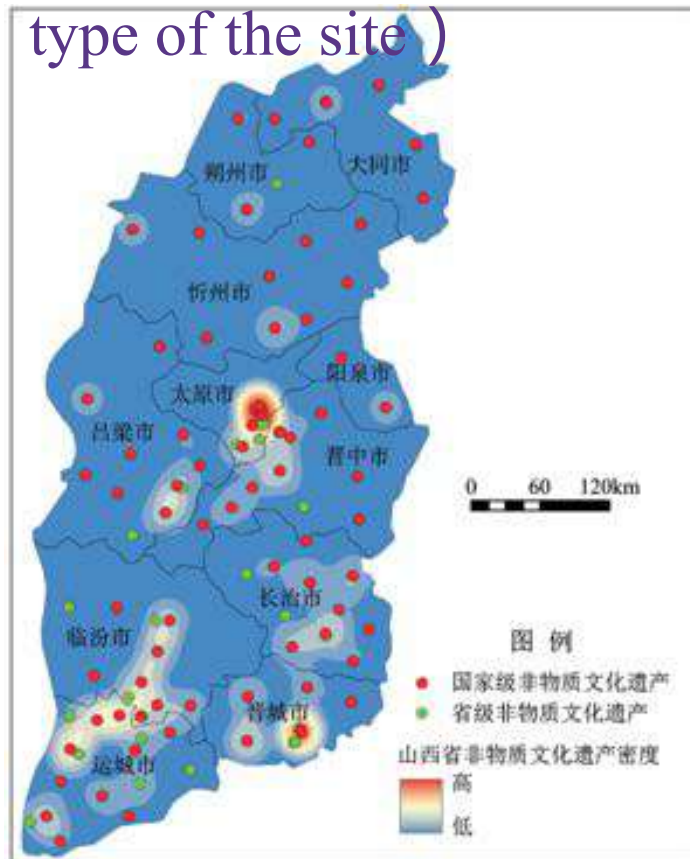
$b_{h,i}$ = Total amount of annual budget provided for maintaining cultural and natural heritage in the year i

B_i = Total amount of annual public budget in the year i

Rationale and interpretation: Protecting and safeguarding the world's cultural and natural heritage require public investment at different level of governmental including at city level. This indicator would allow insight whether countries are maintaining, expanding or decreasing their efforts for safeguarding their cultural natural heritage.

3 New methods

- ◆ Construction of Evaluation Index System for Disaster Prevention and Reduction Capability (Measuring the spatial aggregation type of the site)



$$R(s) = \sum_{i=1}^n \frac{1}{t^2} k\left(\frac{s - s_i}{t}\right)$$

Kernel Density

3 New methods



◆ Construction of Evaluation Index System for Disaster Prevention and Reduction Capability (Measuring the spatial aggregation type of the site)



Terraced heritage area and buffer distribution
(above)

Planning area protection grading map
(as shown on the right)



图3 规划区保护分区图

3 New methods

◆ Construction of Evaluation Index System for Disaster Prevention and Reduction Capability (Measuring the spatial aggregation type of the site)

- ✓ Ratio of the area of the site to the population (R_h) :

$$R_h = \frac{A_h}{P} * 100\%$$

Where, A_h = area , P = the person's number

- ✓ Proportion of the area of the site and the total area of the area (R_H) :

$$R_h = \frac{A_h}{S} * 100\%$$

Where, A_h = area of sites, S = total area

- ✓ Construction land accounts for the proportion of the total area of the buffer zone (R_a) :

$$R_a = \frac{A_b}{A} * 100\%$$

Where, A_b = area of construction land, A = total area of the buffer zone.

4 Our related work

3D modeling of DaZu Thousand-Hand Bodhisattva Statue in China



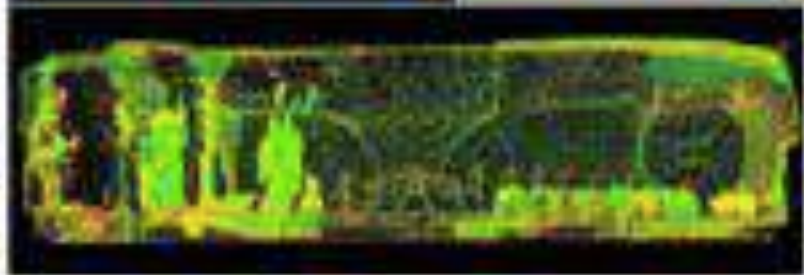
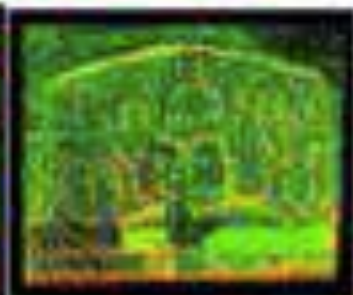
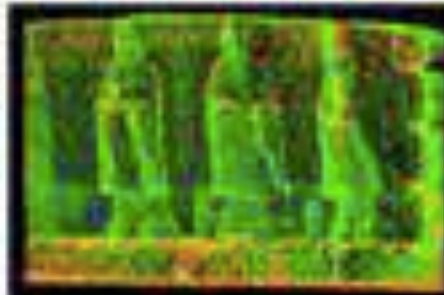
Dazu Thousand-hand Bodhisattva Statue in China



Width is
10.9

Height is
7.7

☆ This is the 3D cloud points of DaZU in Chongqing



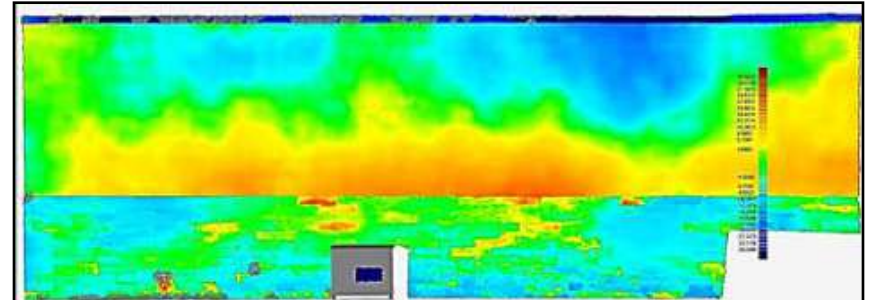
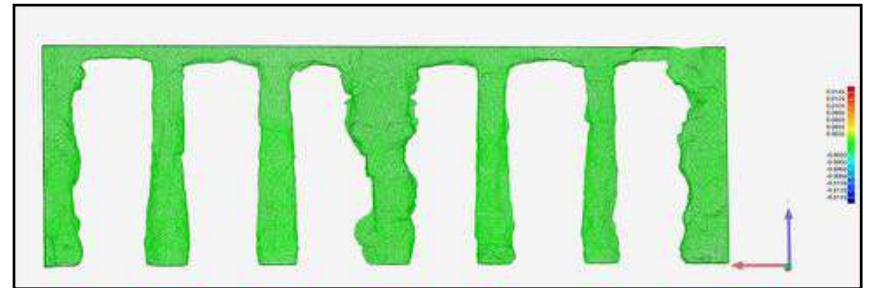
4 Our related work

Beijing Cultural Relics 3D Point Cloud Spatial Information Database



The demand for cultural heritage protection is obvious

- BIM modeling based on point cloud data
- Using point cloud data to grasp the basic state of cultural heritage



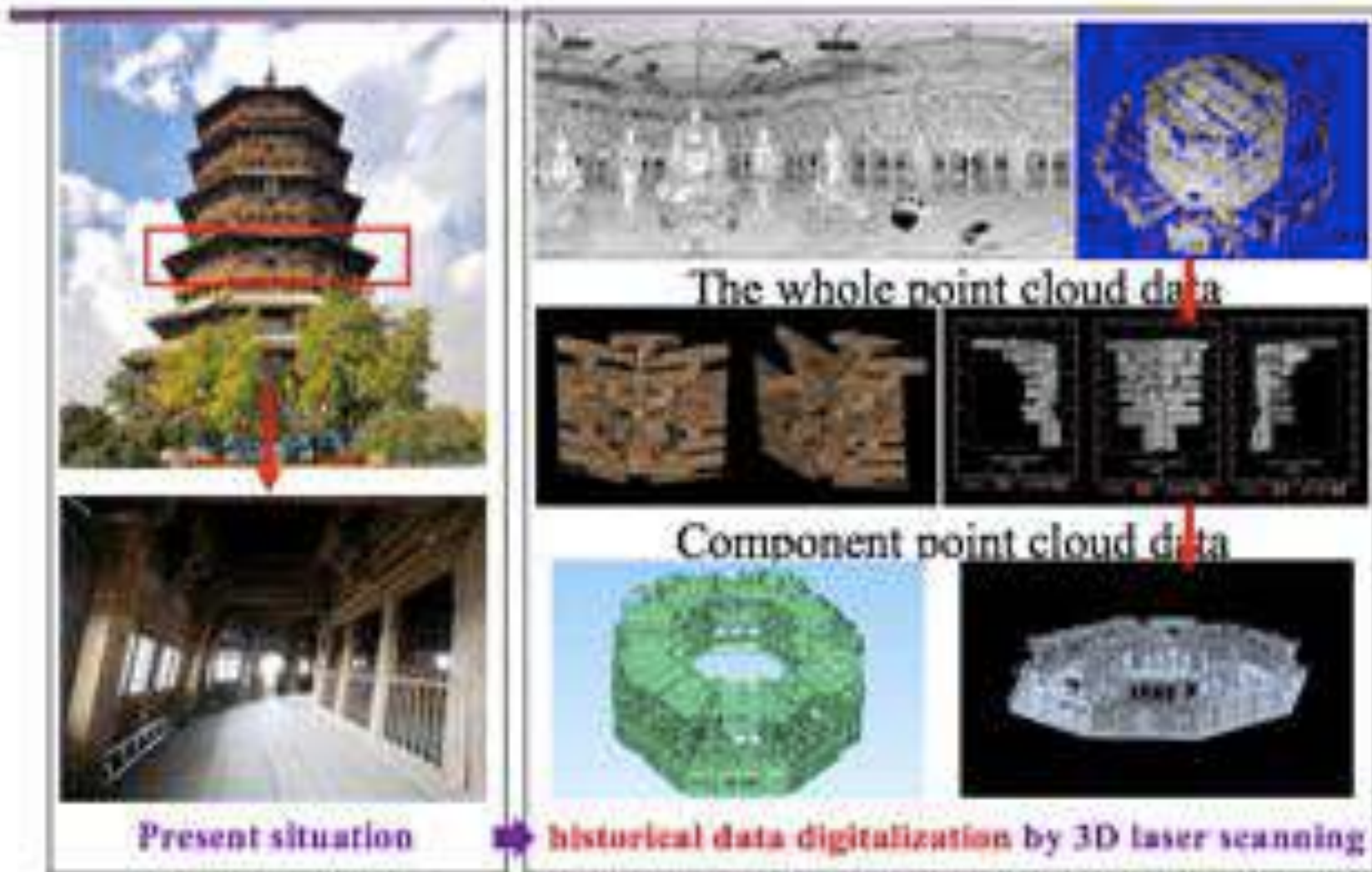
4 Our related work

3D printing of Cave 18 of Yungang Grottoes



Multidisciplinary intersection : architectural history and culture, three-dimensional digital measurement, material science, three-dimensional sculpture, structural analysis, etc.

4 Our related work



BIM for the Yingxian Wooden Tower

Conclusion



- We already have collected a large number of geography data, including 3D model, about our research heritage sites for almost ten years.**
- We just began to use geography data to develop the 11.4 indicator, mainly about heritage of SDGs.**
- In the future, we can use the indicator we developed to show the sustainable status of heritage. And help the government to make it better in the future.**