

WP23_25: Earth Observations for Global Typical Karst

1534,242

Basic Information

Full title of the Initiative

Earth Observations for Global Typical Karst

Short Title or Acronym

EO4KARST

Current category in the 2020-2022 GWP

New activity

Proposed category in the 2023-2025 GWP

Pilot Initiative

Points of Contact

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Purpose

Objective

Objective 1: Enable effective data sharing on karst resources and environment based on observation networking in typical karst areas.

Objective 2: Establish comprehensive models for karst areas' sustainability under human activities in water resources, land resources and landscape resources, which could be important references for policies making.

Objective 3: Develop an intelligent system for users to assess the status of resources and environment in typical karst areas and make early intervene for possible hazards, share the related data and support for related policies making.

Objective 4: Foster outreach and capacity building for the use of the outputs through training, education, internship, workshops, etc.

Please provide a short description of the Initiative

As a GEO pilot initiative, EO4KARST would like to support the sustainable development of karst areas in context of their abundant resources but fragile environment. The Initiative wants to realize the support from the following approaches: 1) to set up a database that could be accessed easily by the users based on the data from the enlarging observation network for typical karst areas on resources and environment that integrate RS data and in situ observation data and keeps enlarging by absorbing the existing observation stations or the newly set up stations in typical karst areas; 2) to develop integrated models by taking karst resources sustainable utilization into consideration to find out the thresholds that may guide human's over development; 3) to develop an intelligent system (integrating control centre and an app) that could be used for the decision makers to make policies based on the models, or for the administrator to make early intervene for the possible hazards; or for the common users to share the related data; and 4) to make outreach and enhance the capacity building through products generation and activities like training, further education, internship, workshops, science popularization, etc.

Why is this Initiative needed?

Karst distributes widely in the world, covering about 22,000,000 km² of the land. Currently, about 16.5% of the global population lives in karst areas, and about 25% of the world population lives on karst water. Karst is featured by beautiful landscapes (e.g. South China Karst World Natural Heritage), abundant water resources that are not stable because of the double hydrogeological structure (aboveground and underground are connected by conduits or fissures due to the dissolution of the carbonate rocks). The soluble rocks and double hydrogeological structure enabled easy impacts of human activities on surface to the underground and spread to other parts through the conduits network. How to calculate the threshold of human activities to restrict the bad influence is in a urgent need now, yet there is not any work focusing on this point.

What evidence is there to support this need?

The prominent problems attract common attention about karst mainly present in water resources management, karst environment sustainability, as well as karst landscapes conservation and sustainable tourism development. (1) Karst water resources management In karst areas, water resources are not stable because of double hydrogeological structure, the surface water system and groundwater system are connected well by conduits or fissures formed because of the dissolution of the soluble rocks like carbonate rocks. This special double-layered structure makes karst water resources difficult to be exploited and utilized, since the well-developed fissures or conduits enable easy infiltration of surface water, and the soluble rocks make an uneven distribution of karst water. Consequently, the water quantity is unbalanced spatially and temporally leading frequent floods and droughts in karst areas. Under the impacts of human activities with the background of global change, the karst water quantity has lowered seriously. Taking north China as an example, about 80% large karst springs present a continuous diminishing trend, while 30% large karst springs cut off or almost cut off. For instance, the total flow rate of 15 karst springs in Shanxi, with the average flow rate decreased from 73 m³/s in 1956 to 34.84 m³/s in 2008. Therefore, karst water resources management is in an urgent need to sustain its utilization. It is necessary to use observation network that combined RS technology and in situ monitoring stations together to provide useful data for locals. The locals may take corresponding measures like constructing water tanks or reservoirs for water storing when dry season comes, digging tunnels for dewatering when wet season comes and even constructing dams and other complex facilities to adjust connected surface water and groundwater. (2) Karst environment sustainability --- Karst land use management Karst environment is characterized by slow soil formation rate, with the rate as 1/40-1/30 to that of silicate areas, the well-developed underground rivers network makes the surface water hard to be stored and uneven distribution of water resources hinders effective utilization of groundwater. Thus, it is difficult to design an effective land use pattern for karst areas. Taking the extreme example of karst area---rocky desertification as an example. Rocky desertification is a phenomenon refers to the processes and human activities that transform a karst area covered by vegetation and soil into a rocky landscape. It is influenced greatly by different land use. Rocky desertification disables sustainable development of local communities, since it results in biodiversity reduction, hydrogeological change, blocking the underground conduits, and less farming outputs. It is necessary to find out the most suitable land use patterns in karst areas to mitigate the hazards like rocky desertification and benefit more environmental effects. Taking Yunnan province of China as an example, the ratio of rocky desertification changed as follows from 2000 to 2020, the area without rocky desertification changed from 62,459.24 to 74,720.13 km², the potential area with rocky desertification changed from 18,895.02 to 18,391.77 km², the area with light rocky desertification changed from 3,849.05 to 4,402.55 km², the area with moderate rocky desertification changed from 5,644.20 to 4,976.98 km², the area with severe rocky desertification changed from 19,957.55 to 16,322.75 km², and the area with extremely severe rocky desertification changed from 7,500.45 to 8,031.49

km². The current land use in Yunnan province includes farmland, forest land, grassland, brush land, wetland, water area, construction land, bare land and ice covered land. Different categories of rocky desertification have different changing trend for different land use patterns, the rocky desertification in farmland increased gradually, also in grassland except the area with extremely rocky desertification; while that (except the area with extreme severe rocky desertification) in forestland and brush land decreased gradually in general; in addition, the rocky desertification in other types of land use also decreased. According to the recent national key R&D Program of rocky desertification control in Yunnan Faulted Basin, the basin could be used for farming, while the slopes could be used for bushes (e.g. marigold) and forests, and the plateau could be used for fruit trees. This land use pattern enables a positive impacts of human beings to the environment, not only helps locals to control the rocky desertification, but also develops a sustainable ecological industry to increase economic benefits for locals. The results indicate a necessity to find out suitable land use for karst areas to balance environment problems and economic development. (3) Karst landscapes conservation and geo-tourism development Actually, karst landscape is a complicated conception combined the classical geosites with special karst ecology and even local cultures. For this Initiative, the observation of the landscapes will focus on specific geosites, like a cave or a hill. Usually, these geosites will be the highlights of a tourism attraction, and is easily to be affected by human activities, like over tourism. For instance, the show caves (Yinzi Cave, Reed Flute Cave, Crown Cave, etc.) in Guilin are influenced by visitors seriously. These caves suffered stalagmites crust weathering, crust falling off, algae intrusion because that the lights of the show caves and CO₂ dynamic change due to visitors influence the habitats of caves and result in serial environment change that influence the original status of landscapes (e.g. the stalagmites darkened). Although some degradation of karst landscapes are naturally, like natural weathering, tectonic movements (e.g. earthquakes), yet human activities are important factors that influence the karst landscapes. It is necessary to monitor the circumstance, including the CO₂ content, humidity and temperature to evaluate the impacts from the visitors to the caves. Another important phenomenon about specific geosites is the natural influence that may destroy them and impact human safety. Take the karst hills in the ocean (karst islands) of Thailand as an example, the isolated karst islands which present in inverted triangles have quite unstable base, the base is seriously affected by the shock and erosion of seawater and the islands may finally fall down. It is necessary to monitor the fluctuation of the waves and the erosion rate of the seawater nearby to provide early warning of the possible falling down time, and then propose suggestions for locals to take responding measures to prevent the possible falling. Therefore, it is necessary to set up an observation network to monitor the status of karst geosites for sustainable geo-tourism development in karst areas, especially for the typical geosites like karst related UNESCO Global Geoparks (e.g. Zhijindong Cave UGGp) and World Natural Heritage sites (e.g. Wulong Karst in Chongqing and Shilin Karst in Yunnan).

Is this Initiative open to participation by representatives of any GEO Member, Participating Organization, and GEO Associate?

Yes

Are you aware of other projects or initiatives at a global or regional scale (both in GEO and externally) that provide similar products or services?

No

Please identify the most important actual and/or intended outputs (products, services, etc.) produced by the Initiative, along with their intended and/or actual users. This list does not need to be comprehensive but should identify the outputs which are most used and are expected to have the greatest potential impact.

Output	Status	Users	Additional info
Karst environment and resources database	In development	The practitioners in the countries involved in this initiative	Integrating karst environment data, water resources data, landscape resources data, which will be updated regularly
EO4KARST intelligent system	In development	The decision makers of the related countries, the administrators of the areas under in situ observation, the participants of the initiative	The intelligent system integrates a control centre and an app. The control centre could be used by the administrators to make early intervene for possible hazards, while the app could be used for early warning, data download and upload.
Sustainable development models for typical karst areas	In development	The decision makers of the countries involved in this initiative	Integrating the models for karst water resources sustainable utilization, karst land resources sustainable utilization, and karst landscape resources sustainable utilization.
The international standards on sustainable utilization of karst landscape resources	In development	Karst geosites administrations and its technical supporting team involved	Focus on karst landscapes protection and sustainable development in tropical and subtropical zones at first; the other standards is planned to be developed in future.
EO4KARST outreach products(like brochures, video,etc)	In development	All the decision makers of related countries, the practitioners of related countries	Mainly introducing the possible trends of resources and environment of karst areas under current development predicted according to the models, and the EO4KARST intelligent system which will be useful for kinds of users

If needed, please provide additional comments or explanation to accompany the outputs table

Based on the enlarging global observation network on typical karst areas, it is necessary to establish a karst environment and resources database that will benefit all the related stakeholders. During 2023-2025, the Initiative is hoping to establish 3 new observation stations in Southeast Asia (i.e. Thailand, Indonesia, and the Philippines) and absorb 1-2 observations stations in Serbia of Europe and South Africa of Africa respectively, enriching the data of the observation network.

Then, it is important to set up an integrated model for sustainable development in typical karst areas based on the database to find out the thresholds of different impacts from human activities. During 2023-2025, the Initiative is hoping to set up 3 models for karst water resources sustainable utilization, karst land resources sustainable utilization and karst landscape resources sustainable utilization preliminarily.

Moreover, it is useful to develop an intelligent system for users to assess the status of resources and environment and share the data, which could be used by the decision makers for policies making in a more convenient way, and by the administrators for possible early intervene for possible hazards and for common users to realize data sharing. During 2023-2025, the control centre will be set up with the in situ monitoring information from Southeast Asia and China, and the app will be developed and try to promote to Thailand, Indonesia, the Philippines, Slovenia, Serbia, Brazil, South Africa and Zimbabwe.

In addition, it is necessary to develop some international standards for the sustainable development, for the period from 2023-2025, we'd like to develop the standards on sustainable development of karst landscape resources preliminarily, which is also easy to be conducted in related countries.

Finally, it is necessary to organize outreach and capacity building activities to promote the related products and raise the public awareness on karst. Moreover. During 2023-2025, the Initiative will generate 1-2 outreach brochures, organize 2-3 training courses, 2-3 workshops and 2-3 science popularization activities. All the outputs will be shared to all the countries involved in this initiative, and keep opened to new partners and keep improved or updated.

What kinds of decisions are the outputs of this Initiative primarily intended to support?

(1) Sustainable management of karst water resource. (2) Sustainable management of karst land resources. (3) Sustainable development of karst landscapes

How will these decisions benefit from the outputs of this Initiative?

The outputs will benefit decisions on karst water resources management, land use management and landscape resources conservation; also benefit the administrators of the areas under observation for early intervene for possible hazards; and benefit for common users like researchers to share the related data. The outputs mutually affect each other, the database will collect and organize the data from the enlarging observation network combining in situ observation stations and satellite remote sensing; the models will analyze kinds of possibilities based on well organized data and provide reference for decision makers on the development patterns for sustainability; the intelligent system will generate a control centre and a convenient app based on the database and models that will reflect the possible trends of the resources and environment of karst areas under current impacts from human activities for decision makers, provide early warning to the administrators for possible hazards and provide convenience for common users to download or upload related data; the international standards will be useful for the practitioners in the related areas; and the brochures will be an effective pattern to advertise the outputs of the initiative to the public for better protection of karst resources and environment.

What kinds of impacts (for example, reduced loss of life, monetary savings, conservation of biodiversity, etc.) are anticipated as a result of the use of the outputs of this Initiative?

In typical karst areas, first, improve karst water resources management with high-efficiency and sustainable pattern to use karst water resources; second, sustain a healthy environment to conserve biodiversity and prevent soil erosion or leakage; third, improve the development patterns by reducing negative impacts to karst landscapes.

Has this Initiative been asked to provide specific information (for example, reports, data, services) on an ongoing basis to an international convention, organization, or other multilateral body?

No

Technical Synopsis

Please provide a brief description of the methods used by the Initiative to produce its

(actual or planned) outputs.

(1)For the database and intelligent system, it is planned to use 3S (RS, GIS and GPS) technology to set up a database based on available data, which will also be used to benefit related countries by integrating big data platform computing power and artificial intelligence algorithms. The database will adopt monitoring data from the observation network (for soil, e.g.temperature, humidity, salinity, etc.; for water,e.g. flow rate, temperature, conductivity, pH, etc), related topographic maps, high-resolution RS images. The database will adopt kinds of technologies and methods like the automatic and human-computer interactive image processing, multi-source information interpretation, in situ investigation, spacial measurement, and geographic calculation. The database will collect and classify different data for water use, land use, and landscape use to support the generation of related outputs. The data quality can be improved via data cleaning and fusion.For the intelligent system, physical simulations, data mining, and other approaches should be combined to achieve the modularization of service functions. Additionally, the goals of intelligent monitoring, early warning, display and data download and upload on multi-dimensional platforms such as control screen, PC, and mobile apps should also be achieved.

(2)For the model, it is planned to use three kinds of analysis to set up the model. For karst water resources sustainable development model, it is planned to use System Dynamics (SD) and Multi-objective Optimization Method (MOM) to establish a model for karst water resources balance and optimization. For the land resources sustainable development model, it is planned to use Drive Force (D)-Pressure(P)-State(S)-Impact (I)-Response(R) (DPSIR) to establish a model for the land resources sustainable development, it is planned to take nitrogen and phosphorus balances as the as a main parameters for land resources balance, then it is possible to establish a model to figure out the limits for some kinds of land use. For the landscape resources sustainable development model, it is planned to use matter element analysis, analytical hierarchy process (AHP), BP neural network analysis method to analyze the questionnaire and observation data, then figure out the limits for karst resources development, and use Moran index to analyze the environment change, then use STATA software to interpret the coupling relationship between karst landscapes development and environment protection, then based on Environmental Kuznets Curve, to develop the model for karst landscape resources sustainability. The project will integrate the models for karst water, soil and landscape together to formulate a comprehensive model.

(3)For the international standards, due to the requirements of on-going projects, it is possible to develop an international standards on karst landscapes sustainable utilization at first. The standards on water and land sustainable utilization in karst areas worldwide is also possible to be developed when collect sufficient data and demonstrate in typical karst areas.

If you would like to provide further details on the technical methods, you may upload one or more documents here.

- no supporting documents provided -

Are there any significant scientific or technical challenges that need to be resolved by the Initiative during the 2023-2025 period?

No

Does the Initiative expect to complete any key new outputs, improvements to existing outputs, or improvements to the methods of producing outputs, in the 2023-2025 period?

Yes

Please describe these new outputs or improvements.

It is planned to establish 3 more observation stations in Southeast Asia, and absorb 1-2 observation stations to enlarge the existing observation network on karst. It is planned to establish preliminary comprehensive models to give a reference for the decision-makers to make relative policies for sustainable development of karst water, land use and landscapes in typical karst areas; the EO4KARST intelligent system will enable effective and convenient usage of database for different users; while the international standards on karst landscapes sustainable utilization is going to focus on tropical and subtropical zones at first, which will be useful the SE Asia whose management on karst landscape is developing; and the outreach products will be

made in brochures or videos which will be easily to be used for the advertisement of the Initiative's achievements and help to raise the public's awareness on karst sustainable development.

Please identify the key tasks that must be implemented to ensure delivery of these changes, with target dates for completion.

Task	Task description	Expected completion (month/year)
Enlarge current global observation network on typical karst areas	The Initiative is hoping to establish 3 new observation stations in Southeast Asia (i.e. Thailand, Indonesia, and the Philippines) and absorb 1-2 observations stations in Serbia of Europe and South Africa of Africa respectively, enriching the data of the observation network.	10/2024
Establish karst environment and resources database	Establish a database collecting karst water monitoring data, karst land use monitoring data, environment data of typical landscapes as famous tourism attractions(e.g. water quality, air quality, noise decibel, etc.); RS data about vegetation and visible landscapes changes.	11/2024
Develop sustainable development models for typical karst areas	Develop the models for sustainable development on karst water resources, land resources, and landscape resources. Demonstrate them in typical karst areas and keep improving.	12/2025
Develop EO4KARST intelligent system	Develop an intelligent system integrating control centre and a simple app to the decision makers, administrators of the areas under the observation, and common users. The control centre is used mainly for the administrators of the areas under in situ real-time monitoring, while the app could be used for kinds of users. For the decision makers, they could use the app to know different trends predicted by the proposed models for better policies making. For the administrators, they could use the app to know the real-time monitoring status of the areas they are in charge, and make early intervene to the possible hazards from the control centre. For the common users, they could download or upload the related	12/2025

	data for wider sharing through app.	
Develop the international standards on sustainable utilization of karst landscape resources	Develop an international standards on sustainable utilization of karst landscapes	12/2025
Organize outreach and capacity building activities	Generate 1-2 outreach brochures, organize 2-3 training courses, 2-3 workshops and 2-3 science popularization activities	12/2023 12/2024 12/2025 Each year will organize at least one event

Resources

Have all resources required to implement the Initiative's planned work in the 2023-2025 period been secured?

- Gap in financial resources
- Gap in access to data

What is the estimated funding gap for the 2023-2025 period?

50,000 USD

What data sets are needed by the Initiative but are not currently available?

Water quality and quantity data in some catchments of southeast Asian countries, soil data in all the countries involved except China, air quality and guest flow of classical tourist attractions featured by karst landscapes in all the countries involved.

What actions is the Initiative taking to obtain the required resources?

For the financial gap, the proposer of the initiative, UNESCO IRCK, is planning to apply for more funds from multiple channels, like applying for new projects from related countries, from international organizations, or even ask some possible coordination of GEO secretariat to help to contact the suitable agencies to invest in the initiative. Due to the long term cooperation between abovementioned countries, IRCK has the confidence to solve the resources gap. For the gap in access to data, since the collaborative countries in this initiative have different research status about karst. U.S. and China have more detailed data, while other countries involved may have different available data, some required data may even not observed yet, like the air quality and guest flow of famous tourism attractions featured by karst landscapes, which are important for the model on sustainable utilization of karst landscape resources. Therefore, the initiative is planning to set up in situ monitoring systems in related countries and try to realize automatic real-time transmission of the data.

Please list all financial and non-financial contributions to the Initiative (other than in-kind, voluntary participation by individual contributors) having a value of more than USD 50,000.

Contributing Organization	GEO Status	Type of Resource	Value	Currency
Guangxi Department of Science and Technology	China	Financial	3,760,000	CNY
Ministry of Science and Technology	China	Financial	1,500,000	CNY
China Geological Survey	China	Financial	1,000,000	CNY

Lessons from the 2020-2022 Period

Were all planned activities for the 2020-2022 period implemented as expected?

No

Please describe which activities were delayed or not implemented and how has this affected plans for 2023-2025.

This is a new initiative.

Were there any key challenges faced by the Initiative in the 2020-2022 period?

No

Were there any impacts or changes to operations due to COVID-19?

No

Please describe the key changes proposed for the 2023-2025 period, for example, new projects, new areas of focus, or adjustments to the activity governance.

This is a new initiative for 2023-2025 period, it seems no relative initiative in last period.

Does the Initiative have outputs (products, services, etc.) available to users now, even if only on a pilot or testing basis?

No

Do you have evidence of any impacts that have occurred in part as a result of using the outputs of the Initiative (for example, policy decisions taken, behaviour changes by users, risks mitigated)?

No

Have there been any internal or external reviews or evaluations of the Initiative since 2019?

No

Please indicate any GEO Work Programme activities with which you have ongoing collaboration.

Please indicate any additional GEO Work Programme activities with which you would like to establish new collaborations.

- AQUAWATCH - AquaWatch
- CSDR - Chinese High-resolution Satellite Data Resources
- GEO BON - GEO Biodiversity Observation Network
- GEO Engagement Priorities Coordination - GEO Engagement Priorities Coordination
- GEOGLOWS - GEO Global Water Sustainability
- GEO Work Programme Support - GEO Work Programme Support
- GEOARC - Global Ecosystems and Environment Observation Analysis Research Cooperation

Stakeholder Engagement and Capacity Building

Are there specific countries or organizations that your Initiative would like to engage?

Yes

Please list these countries, regions or organizations.

Brazil, Indonesia, Romania, Serbia, Slovakia, Slovenia, South Africa, Thailand, the Philippines, United States, and Zimbabwe. Man and the Biosphere Programme (MAB); International Geographical Union (IGU); International Hydrological Programme (IHP); International Association of Hydrogeologists (IAH); International Union for Conservation of Nature (IUCN); International Union of Geological Sciences (IUGS); International Organization for Standardization (ISO); United Nations Educational, Scientific, and Cultural Organization (UNESCO)

What are your plans to engage them?

For the countries including Indonesia, Serbia, Slovenia, Romania, Thailand, and the Philippines, they have already engaged in this initiative, since they are important partners of the on-going projects supporting this initiative. For the countries of Brazil, Slovakia, South Africa, U.S., and Zimbabwe, they are long-term partners of IRCK, it is planned to engage them in this initiative by signing bilateral cooperative intents for this initiative, and share all the related outputs with them. The scientists from above mentioned countries will act as contact person of this initiative of their countries, managers of the in situ monitoring stations that provided by them, or funded or partially funded by IRCK or set up under the guidance of IRCK, data providers and users of the database, advisors of the initiative, and the lecturers or speakers of the training courses, seminars or popular science activities.

For the organizations, since IRCK has good collaboration with the karst commissions or committees or other counterparts under these organizations, it is planned to engage the organizations in this initiative through joint organization of related seminars and joint capacity building organizations, so as to enable a wider stakeholder community.

Does your Initiative engage users in the work of the Initiative (for example, consultation, testing, co-design)?

Yes

Please briefly describe the Initiative's approach to engaging users.

The Initiative plans to engage the users through the following approaches:

1) For the decision makers, they may use the intelligent system to know the possible trends of the resources and environment status of karst areas under current human activities; for the administrators of the areas under in situ monitoring, they may use the intelligent system to make early intervene according to the early warning from the system; and for the common users, they may download or upload related data to enrich the database. 1) to organize training course, the users will be trained through the training course, which will help them to get better understanding of the outputs; 2) to organize training course with the users as the trainees, which will help them to get better understanding of the outputs and know how to use the outputs; 3) to participate in the demonstration of the model in typical areas and give their opinions to improve the model;

and 4)to organize the workshops with the users attended, during which the outputs and their actual effects will be discussed, the users may provide their opinions on the improvement of the outputs.

Does the Initiative have a user engagement strategy or similar kind of document?

No

Are there categories of users that are not represented at this time, but you would like to engage?

Yes

Please list these user categories or regions.

The practitioners and decision makers in Argentina, Finland, Republic of Congo, Saudi-Arabia, and Egypt.

What are the plans for further engagement of users in the Initiative?

Since they have large proportion of land covered by karst, representing typical karst types that are not covered by the period of 2023-2025. The initiative will apply for more funds through application of projects and share the outputs of 2023-2025 with them by signing collaboration intents or agreements, encouraging them to engage in the initiative and make common contributions to karst world.

Does the Initiative have a documented capacity development strategy?

No

Please describe the approach to capacity development that is being implemented by the Initiative?

(1) Training

It is planned to organize the training courses regularly focusing on the targets of the initiative. The training courses will be organized according to different audience and held by IRCK regularly or irregularly. For the scientists or technicians, the training courses will focus on the scientific or technical issues and the usage of the intelligent system which will be held annually, especially for the young scientists and technicians; for the decision-makers or related administrators, the training courses will focus on the possible policies or measures suggested by the outputs of the Initiative, or the actual effects of these suggestions about policies or measures and the intelligent system usage, which will be held twice or thrice during 2023-2025 period.

(2) Postgraduates and graduates education jointly

It is encouraged to cultivate postgraduates and graduates jointly, especially for the excellent young scientists or technicians who wants study further. It is planned to cultivate 10-15 postgraduates or graduates during 2023-2025.

(3) Visiting research

It is encouraged to invite the well-known scientists to be guest researchers, and guide research or related work. It is planned to invite 1-2 well-known scientists to be invited as the guest researchers during 2023-2025.

(4) Internship

It is encouraged to invite young scientists to carry out internship in IRCK or related agencies, it is necessary for them to understand the physical truth of the studying areas, and it is also necessary for them to understand the applicable methods used for the outputs. It is planned to invite 3-5 young scientists to carry out internship in IRCK during 2023-2025.

Are there any commercial sector organizations participating in this Initiative?

No

Are there opportunities for commercial sector uptake of the outputs of the Initiative?

Yes

Please describe these opportunities.

Currently, the initiative does not include any commercial sector organizations since the outputs are for public welfare. The funder does not require any commercial benefits. However, once the outputs are verified to have obvious economic benefits, the commercial sector organizations are welcomed to participate in the initiative, especially for the high-tech science and technology company (for the intelligent system), tourism companies and eco-industry related companies.

Is there already commercial uptake occurring?

No

Are there opportunities for further commercial sector participation in the Initiative?

Yes

Please describe these opportunities.

After the demonstration of the model to typical karst areas, if the economic income raised, the plan will invite local tourism companies, and eco-industry related companies to join the Initiative for further improvement of the model, and if they feel there is any economic potential, may invest to the initiative. Moreover, if the intelligent system could be used effectively, it is planned to invite the high-tech company to invest the system to assemble more functions even like booking of tickets for famous tourism attractions, and study tour proposal with the real-time environment status of the attractions, which is different from current apps on tourism and may attract more investment from high-tech companies, tourism companies or so.

Does the Initiative have a plan for commercial sector engagement?

Yes

Please describe this plan or upload the relevant document.

- (1) Advertise the economic positive effects of the outputs through kinds of media (like publications, exhibitions or video advertisement) to attract relevant commercial sector organizations.
- (2) Invite the possible commercial sector organizations directly to take part in the related workshops and training.
- (3) Invite the possible commercial sector organizations to invest the initiative, take part in the observation and improve the outputs jointly for better effects after putting into use.

- no supporting documents provided -

Governance

Please describe the roles of each of the key leadership positions, as well as any team structures involved in day-to-day management.

Leader Group: the Leader Group is composed of the leader and co-leaders of the initiative, which have the rights to allocate funds and adopt the final decision advised by the Advisory Group. Since the initiative is supported by 4 on-going projects funded by related agencies in China, therefore, the leaders or their entrusted scientists of the 4 projects will be the leader or co-leaders of the initiative, the leader of the project with the most fund will be the leader of the initiative, with the others acting as co-leaders. Actually the 5 leaders are also the points of contact, with good gender quality (3 female and 2 male) and all young scientists.

Advisory Group: the Advisory Group is composed of the leader and co-leaders of the supporting projects, the well-known scientists of related fields, users representatives, and working groups representatives. They will provide advise and guidance to the work plan and the development plan made by the working groups.

Coordination Group: the Coordination Group is composed of the representatives entrusted by the working groups

and the users. It will coordinate all the requirements from the leader group, participants, and users for resources obtaining, allocation and information sharing.

Working Groups: it is planned to set 4 working groups composed of Karst Resources and Environment Observation Group, Karst Integrated Models Development and Demonstration Group, EO4KARST Database and Intelligent System Development Group, and Outreach and Capacity Building Group. The working groups will implement the research and observation, develop database and intelligent system, set up models and carry out demonstrations, as well as outreach and capacity building.

Is there a steering committee or other governance bodies that advise the Initiative but are not involved in day-to-day management?

No

What methods does the Initiative use to communicate with its participants?

- Email / e-newsletters
- Regular conference calls
- Website
- Regular events

Please describe the key risks that could delay or obstruct the completion of the planned activities and outputs of the Initiative, along with any actions taken to mitigate these risks.

- no answer given -

What methods are used by the Initiative to monitor its effectiveness?

- Informal discussions with users / beneficiaries
- Website statistics
- Consultations or events
- Evaluations

Would the Initiative be interested in assistance from the GEO Secretariat for developing an impact plan?

Yes

How are the results of the monitoring and evaluation activities shared with participants and the wider GEO community?

1) Database and intelligent system (share the monitoring activities)

For the data: the portal of the database will be presented on the web page of IRCK (UNESCO International Research Centre on Karst) or through the app, all the participants could access to the database for authorized data according to the laws and regulations of each country, the wider GEO community could access to the monitoring data after registration. For common users, it is possible to download and upload authorized data through the app for more convenient sharing of related data.

For other monitoring activities: the new participants could sign agreements or intents with IRCK to join the initiative and engage at least one existing monitoring station (if available) of typical karst catchments in their countries to this initiative, the new monitoring station will be enrolled by the observation network in 2 months; however, if they do not have existing monitoring stations, IRCK will grant a guideline to guide the construction of monitoring stations which will be undertaken by the new participants, once the new monitoring stations be set up, it will be absorbed by the global observation network.

2) Take part in the evaluation activities

First, the participants will be invited to develop the evaluation reports jointly; second, the workshops or seminars for the evaluation activities of the initiative will also invite the participants representatives to attend, then they may know the evaluation status and provide necessary supplement to the activities.

3) Publications (share the evaluation)

The participants will generate the publications like newsletters, posters, guidelines, books and papers in hard

copies or digital formats jointly for the evaluation, which will be uploaded to the website of IRCK and could be downloaded freely, so as to share the results with the participants and wider GEO community. Moreover, it is planned to use app to transfer the files end to database.

Are any monitoring or evaluation activities required by funders/contributors?

Yes

Please describe and provide reports if available.

The funders/contributors also require monitoring and evaluation activities, however, yet the supporting projects are newly funded, the final reports will be generated and submitted at the end of the projects. As the on-going projects set, the monitoring stations will be set up in typical karst areas in Indonesia, Thailand, the Philippines, and the existing monitoring stations in Slovenia, Serbia and Romania will be enrolled by the global observation network. Meanwhile, the RS technology will be used to monitor the vegetation and landscape resources degradation.

- no supporting documents provided -

Participants

Please list the active individual participants in the Initiative

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Other information

Please provide any other comments or information that was not included in the previous sections, but you would like to appear in the Implementation Plan.

In a word, by following the laws and regulations of all the involved countries, the initiative is aiming to enable an effective sharing of the data on karst resources and environment under the impacts of human activities based on the enlarging global karst observation network and an intelligent system, which may also help to make related policies and realize the early intervene for possible hazards in karst areas. The Initiative is hoping to find out a practical guidance for the sustainable development of karst areas under the impact of global change, make contributions to the UN SDGs and GEOSS. As a UNESCO centre established since 2008, IRCK has a long-term stable team involving different countries, and also has an initiative observation network on karst, yet the sharing of the data is in low efficiency. It is necessary to use modern methods to realize the convenient and in time sharing of the data, which will be very useful for locals to access to sustainable development of karst areas.

- geo_karst_implementation_plan_1_0713.pdf ([link](#))

Co-Editor Management

List of co-editors for this initiative

- no answer given -