Data Analysis and Integration System (DIAS)

1. Executive Summary

·Existing or proposed category: Existing as GEO community activity. Proposed as GEO Initiative.

·Overview:

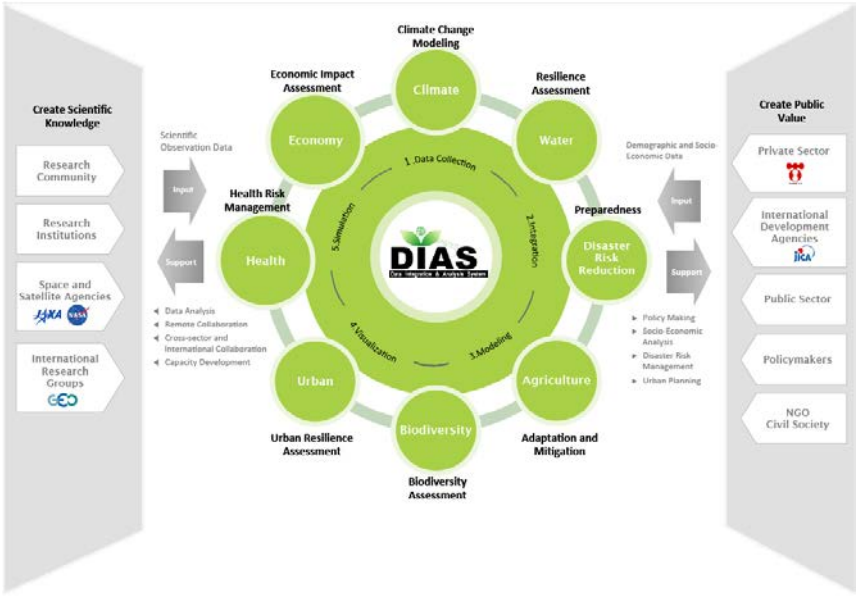

Figure 1. Functions and Structure of DIAS

The Data Integration and Analysis System (DIAS) Initiative for 2020 – 2022 GEO Work Program will encompass the present DIAS, Water Cycle Integrator (WCI), Asian Water Cycle Initiative (AWCI), and African Water Cycle Coordination Initiative (AfWCCI) CAs and will coordinate their activities in line with the GEOSS Water Strategy recommendations. At the same time, DIAS CA will continue to use the Integrated Global Water Cycle Observations (IGWCO) Community of Practice for coordination with other Water SBA activities.

DIAS is an advanced GEOSS-compliant e-infrastructure component that addresses the challenges of a large increase in the volume of Earth Observation data by developing a core system for data integration and analysis. In the arena of water, DIAS has been developing the Water Cycle Integrator (WCI) function, which enables a holistic approach towards solutions to water-related issues by (i) harmonization of data collection and management and improvement of data interoperability and (ii) providing tools for integrating observations, modeling, research, analyses, and management systems across SBAs. The WCI efforts have been reflecting on the experiences of the

Asian Water Cycle Initiative (AWCI) and responding to the community requirements in the data and science integration field. The AWCI community has exploited the DIAS and WCI capabilities and demonstrated extensively their potential. The WCI function has also been recognized by the African Water Cycle Coordination Initiative (AfWCCI) community as a powerful tool for implementing Integrated Water Resources Management (IWRM) in transboundary basins and plans have been outlined for pilot projects.

In addition, DIAS is committed to contributing to society's adaptation policies for various time scales of climate change and weather events. For long-term climate change of several decades, DIAS contributes to sustainable policy decision (disaster prevention, agriculture)at local government level by downscaling the global climate change model and predicting local meteorological phenomena (rainfall, temperature, sunshine) . In addition, a phenomenon (such as drought, infectious disease etc.) that is correlated with the global climate change cycle of a medium term of several months to several years, will be predicted by DIAS which necessary information for stockpiling of local governments and institutions (water resources, medicines etc.). Furthermore, for extreme phenomena (such as torrential rain) after several hours, it is useful for evacuation planning by performing flood and inundation prediction in real time by DIAS.

·Planned Activities:

DIAS Initiative goal is to enable effective and efficient exploitation of earth observation for truly informed decisions in water resources management and disaster risk reduction. This requires a variety of activities that include following objectives:

1) Continue and improve data management covering the full data life cycle while regarding the “Big data” characteristics and in particular expand water-cycle relevant data acquisition and increase its availability and use for research as well as operational use;
2) Advance development of WCI component on DIAS with new tools and functions for interdisciplinary and transdisciplinary collaboration reflecting on (a) user community requirements and (b) opportunities arising from new earth observation capabilities and technologies;
3) Improve understanding of water-related disaster risks and resilience and identify changes in these risks and resilience through research activities exploiting earth observations and novel capabilities of WCI;
4) Provide improved decision and policy-making support including flood early warning systems, drought monitoring and warning systems, and climate change

assessment and adaptation planning tools. Promote and facilitate implementation of these systems in operational use.

5) Human resources capacity building for water issues using inter- and transdisciplinary approach of WCI;

6) Foster regional collaboration and enhance user engagement through AWCI and AfWCCI frameworks and expand collaboration with other regional and global frameworks and donor organizations.

7) Collect and organize traffic, economic activities, industrial location, land use data, etc. related to Japan or overseas. The goal is to make it possible to quantitatively understand what kind of impact the estimated hazard (flood etc.) will have on the local social economy and life of the residents in the application considered in the water application

8) By downscaling the long-term climate change model to the regional level of Japan or overseas and making long-term predictions after several decades locally, it contributes to disaster prevention and mitigation measures at the local government level. It also contributes to changes in crop yields, long-term forecasting of renewable energy supply and policy decisions on local government adaptation policy measures.

9) The risk of inundation in large cities is increasing with the increase of extreme weather such as torrential rain and super typhoon expected from now on due to climate change. We use a hydraulic model based on topographic and infrastructure information of large cities, and use real-time data input functions such as rainfall radar on DIAS and high-speed arithmetic processing to predict the inundation risk of large cities several hours ahead.

10) By developing correlation models of medium-period meteorological cycles (La Nina etc.) and ecosystems (mosquito occurrence etc.) . As a result, developing a model that predicts infectious disease (malaria, dengue fever etc.) outbreak from global meteorological forecast. Call attention to prepare for an infectious disease outbreak to government agencies, medical institutions and private pharmaceutical companies in each.

Point of Contact: (Primary contact person(s) for the Initiative and their mail address).

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2. Purpose

In “Science and Technology Innovation Comprehensive Strategy 2015” (December, 2015 Cabinet decision) compiled by the Integrated Science, Technology and Innovation Conference, climate change modeling and simulation forecasting technology using observation data for the atmosphere, water and land It is required to promote the introduction and utilization of renewable energy, as well as to create a platform that integrates these information. In addition, in the “Plan for the implementation of global observation in Japan in the next 10 years” (August 2015) compiled by the Research Plan and Evaluation Committee of the Science, Technology and Academic Council of the Ministry of Education, Culture, Sports, Science and Technology. Such as development and utilization of global environmental information platform centering on a system with durability and robustness, construction of user interface so that real-time sharing and provision of data can be achieved, and efforts for solution of global social issues. In addition, we are required to promote research and development to extract and utilize higher-order information by incorporating the latest technologies such as deep learning and other technologies.

With this background in mind, the future DIAS will not only archive and provide data such as various earth observation and prediction information, but also social issues such as climate change adaptation and mitigation by integrating and analyzing these data. In addition to widely disclosing to the user applications that contribute to the solution of the problem, it is necessary to construct a platform that allows the users to develop.

Expectations from international organizations to DIAS are high, and the World Bank and Asian Development Bank are funding the following projects.

- Brazil drought monitoring (World Bank)
- Preparation of geospatial information by SPADE (Spatial Data Analysis Explorer) (Asian Development Bank)

In above cases, it is actually used for flood forecasting and drought forecasting, which greatly contributes to reducing mortality, or financial costs.

Once registered in the user account, the data set is open to the public including to foreign countries. In particular, DIAS is characterized by in-situ data being maintained and opened to any user.

3. Background and Previous Achievements

DIAS originated from global environment data repository in the 1980's lead by Late Prof. Mikio Takagi at the Institute of Industrial Science, The University of Tokyo. It has continued to develop with the support of numerous projects.

The phase I project of DIAS launched in 2006, and a prototype was developed in 2010. This project established the world's first platform providing scientific information to evaluate the impact of climate change and plan its adaptation measures on fields such as the water cycle and agriculture, which is based on the diverse and massive integrated data regarding earth observation, climate change prediction, etc.

Phase II started from 2011, with the name changed to the Data Integration & Analysis System Program (DIAS-P). During this phase, the further advancement and expansion of functionality were carried out to apply DIAS as a social and public infrastructure.

Phase III has been underway since 2016, as the Program to Promote the Development of Earth Environmental Information Platform. This project focuses on developing and operating the long-term stable system as a social platform with the aim of providing the service and operating the applications, which would help solve various social problems, including climate change adaptation and mitigation.

In FY 2017, trial implementation of "Sri Lanka flood risk reduction application", "Real-time inundation forecasting system for Tokyo 23 wards", "Malaria infection warning system", etc. was started.

As for "Sri Lanka Flood Risk Mitigation Application", the bias correction of satellite rainfall observation by ground rainfall observation data, geometric correction of Himawari-8, two weeks after the disaster against the heavy rain disaster that occurred in Sri Lanka in May 2017. We implemented a rainfall forecasting, flood and flooding forecasting in real time, developed a platform to provide data, and supported restoration and reconstruction. The system is still operated regularly.

With regard to the "Tokyo 23 wards real-time inundation forecasting system," the high-precision original version with a room for improvement in the calculation speed developed by the research and development community is improved by 50 times or more by the application development community participation. Realizing that one hour's

worth of calculations can be done in 20 minutes, it has made great strides towards realizing real-time forecasting.

The “malaria infection forecasting and warning system” is an application of research on malaria population forecasting using climate prediction information in Africa, and in cooperation with JAMSTEC (Japan Agency for Marine-Earth Science and Technology), real-time infection for each region in Africa. The goal is to develop an application that calculates the number of people. This research is an application that is realized only when advanced academic research in the climatic field and medical field and real-time data acquired from the field are integrated on the platform of DIAS, and it is not only academic value but also social contribution and international cooperation. Since it is also a highly promising task, we examined feasibility and started test

4. Relationship to GEO Engagement Priorities and to other Work Programme Activities

In relation to the Sendai Framework for Disaster Risk Reduction, DIAS predicts accidental floods in cities and river floods with detailed and responsive hydrological model in contribute to reducing the number of disaster fatalities. Some systems have been already applied to Asian countries with cooperation of Asian Water Cycle Initiative (AWCI) and GEO Global Water Sustainability (GEOGLOWS) which are promoted by AO-GEOSS. DIAS will also contribute to realization of the goals of the Paris Agreement by promoting the development of low carbon communities in local governments. Moreover, all of applications on DIAS have close relationships with SDGs targets described later.

-Tokyo 23 wards real-time inundation forecasting system(S-uiPS)

The city inundation prediction model S-uiPS, which has been developed for over 20 years by Waseda University's Professor Sekine, has been implemented in DIAS, and construction of "Tokyo 23 wards real-time inundation prediction system" utilizing various real-time data possessed by DIAS It aims to Newly introduced the river water level data of Tokyo and the Nowcast forecast data of the Japan Meteorological Agency, etc., which were not used in the previous model, and aim for more accurate prediction. A large city such as Tokyo is an artificially created space, so inundation and flooding that occur there can already be predicted characteristics of the method developed by Prof.

Sekine as follows. Enter all detailed information about existing urban infrastructure (roads, sewers, urban rivers, land use situation of block, etc.) and faithfully reflect each function. The accuracy is the same for "a heavy rain we have never experienced" because it does not bring in any kind of hypothesis, correction coefficient or model constant, and performs precise calculation based on only the dynamic principle. Predictable with In this calculation, pump stations and water reclamation centers for sewerage related facilities, underground control areas connected to rivers, etc. are all taken into consideration. As a result, if there were real-time rainfall information and computer resources as input data, it became possible to predict all inundation and flooding conditions.

This system is related to SDGs No. 6, 11, 13.

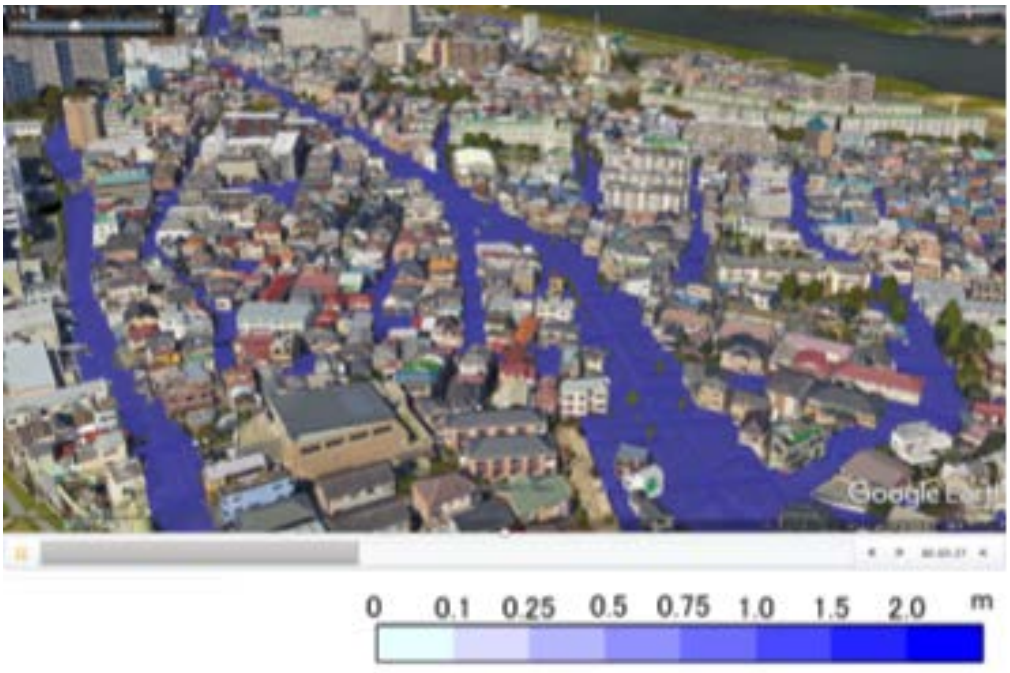

Figure 2. Inundation depth simulation in residential area of Tokyo 23 wards

-Flood Hazard Map Preparation Adaptable to Climate Change - A Case Study on Sri Lanka -

For the worst flooding in 14 years, at least 203 people are dead and more than 96 are missing in Sri Lanka's southwest, the country's Disaster Management Centre said on May 31, 2017.

For water resilience and disaster management in Sri Lanka, the University of Tokyo and ICHARM have developed a data sharing application of flood forecasting on DIAS, and data providing to the local stakeholders has been started in the middle of June, 2017.

Features of this system are as follows.

Various data is accumulated on the DIAS storage in real-time.

Using rain map, flood forecasting in real-time is processed by RRI model.

Basin data utilization API has been developed for the real-time data.

Real-time data is visualized using the basin data utilization API.

This system is related to SDGs No. 6, 10, 11, 13, 14., as well as Asian Water Cycle Initiative (AWCI) .

Figure 3. Flood Hazard Map Preparation Adaptable to Climate Change - A Case Study on Sri Lanka -

-Agriculture Drought Monitoring and Prediction System in Brazil

In Brazil, scientific and technical knowledge for drought monitoring, and some agrometeorological monitoring system have been developed, but not specific tools to

enhance the agriculture drought management. The World Bank has been strongly supporting multiple efforts to strengthen the knowledge and capacity to implement water security approaches globally and the establishment of agricultural drought monitoring and prediction in Brazil in particular. In this context, having learned about ICHARM's agricultural drought monitoring and prediction system, the World Bank commissioned ICHARM to conduct a pilot project on agricultural drought monitoring and prediction over the Northeast Brazil in May 2018.

Assignments and activities as follows.

Components 1

Development of agriculture drought monitoring and prediction system for the Northeast Brazil

Components 2

Development of a tailored system to monitor and predict agriculture drought in the Ceará State

in Brazil

Components 3

Assessment of the pilot's outcomes to develop a strategy for upscaling the system to other States in Brazil, as well as to other LAC countries

We developed the agriculture drought monitoring and prediction system using the CLVDAS as a core model on the Northeastern Brazil on the DIAS. The 1st simulation result on the Northeastern Brazil is shown in the following figure.

This system is related to SDGs No. 1, 2, 3, 6, 8 10, 11, 13, 15.

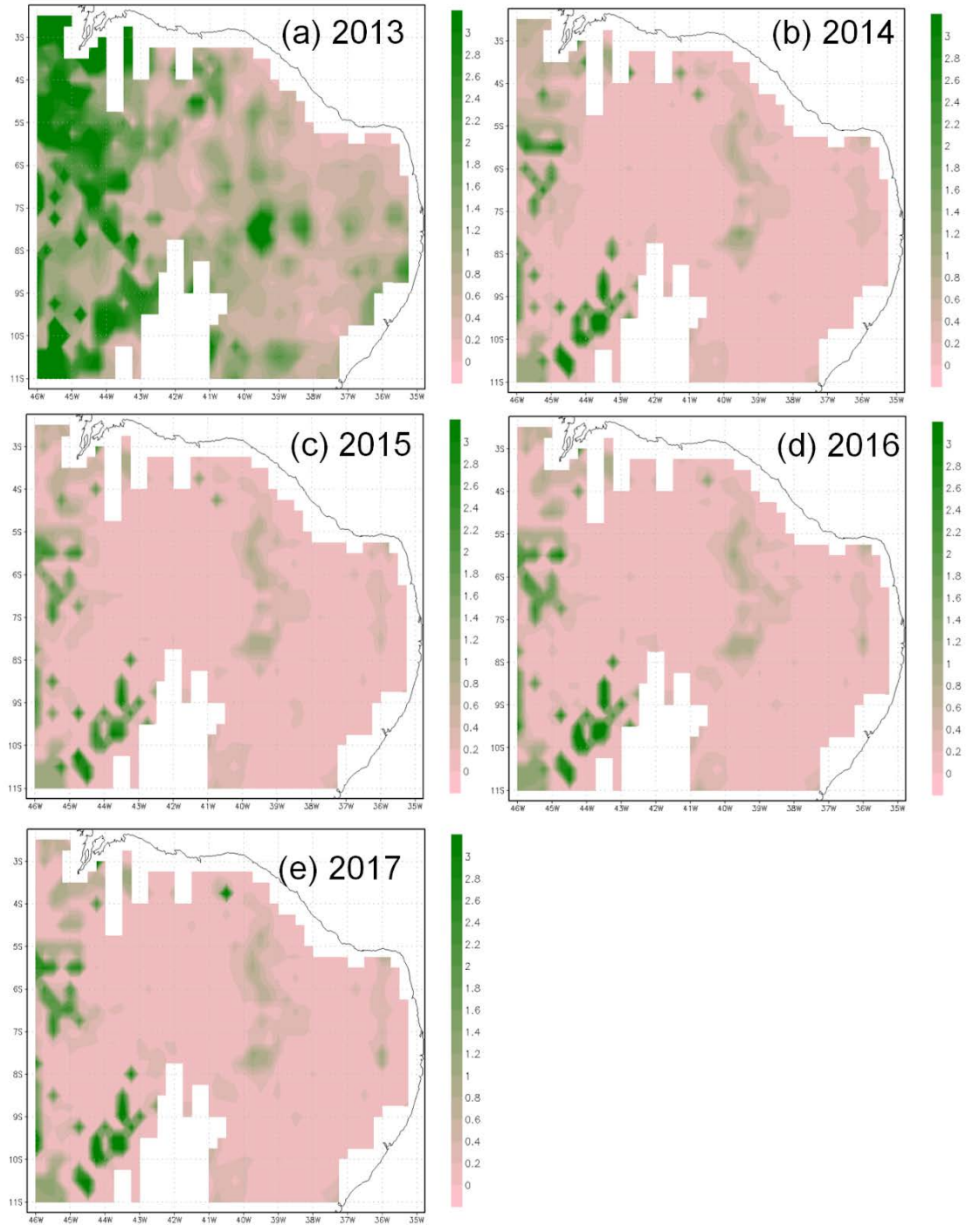

Figure 4. Monthly averaged LAI distribution in January for five years from 2013 to 2017 in Brazil:

(a) January 2013, (b) January 2014, (c) January 2015, (d) January 2016 and (e) January 2017

-Malaria infection warning system

According to 2016 WHO reports, 445,000 people are eliminated by malaria in the Worldwide, mostly children in Africa. Malaria vaccine is not available, bed nets and medicines have limitations. The threat is mounting due to recent climate variations, like La Niña.

In order for preparation for an outbreak stockpiling medicines and insecticides, and inducing behaviour change, automated malaria climate prediction system under the platform of the DIAS was developed. This system successfully reduced agricultural and health risks based on prediction malaria outbreaks with global weather forecasts with help of down scaled regional climate model. This system is related to SDGs No. 1, 3, 10, 11, 13, 14.

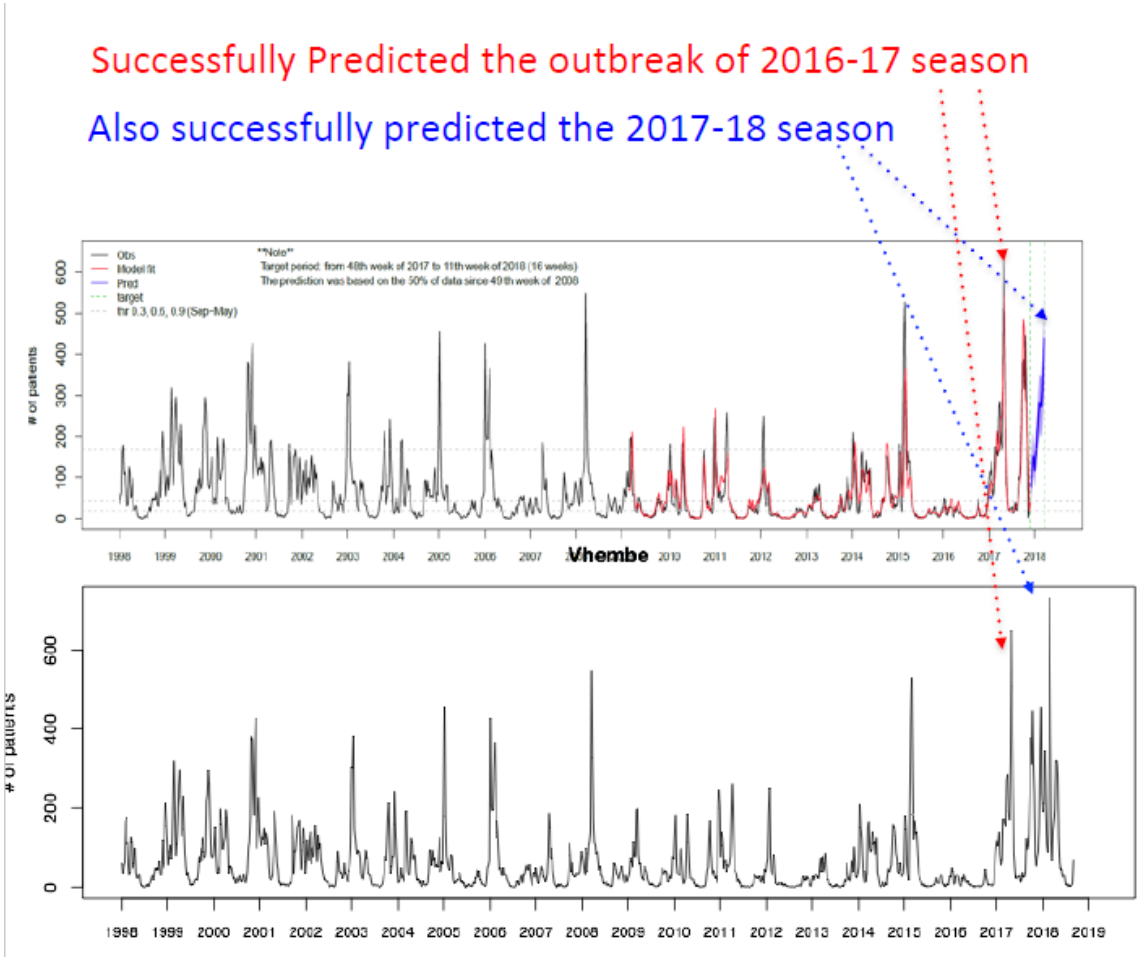

Figure 5. Prediction of Malaria outbreaks

- Resilience and Sustainability Assessment Platform

In conjunction with the Paris agreement and the Sendai Framework for Disaster Risk Reduction. We apply the Resilience and Sustainability Assessment Platform on DIAS to urban and rural areas in order to help the city planning. The planning includes the low carbon town planning with the global warming countermeasure implementation as well as regional disaster prevention planning. Promote the implementation of evaluation models on contingencies (e.g. disasters) in addition to normal evaluation models.

Following table shows lists of DIAS related with SDGs including activities described in advance.

Table 1. List of DIAS applications related with SDGs.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Hydropower application						○	○					○	○				
Sri Lanka Flood Management System						○				○	○		○	○			
Kyushu heavy rain disaster response system						○					○		○				
Real time flood forecasting app (Tokyo 23wards)						○					○		○				
Malaria infection warning system	○		○							○	○		○	○			
Cloud Resolving Storm Simulator (CReSS)						○	○		○		○		○	○	○		
Cambodia Water Management / Agricultural Production Support App	○	○				○		○	○		○	○	○		○		
GMPS tool		○	○			○	○				○		○	○	○		
Brazil Idrought forecasting system	○	○	○			○		○		○	○		○		○		
Ikimoni				○							○		○		○		

5. Stakeholder Engagement and Capacity Building

DIAS Symposium is held once a year in order to make the results of the DIAS project widely known. In 2018, exceptionally, we held a symposium for domestic users in August and an international symposium as a GEO week side event in October. Both had more than 100 participants, with more than half of the participants from the private sector. At the latter symposium, JRC researchers and GEOGLOWS project leaders were invited to give presentation. Participants were full and most were overseas.

Figure 6. DIAS international symposium as a GEO week side event in October,2018 at Kyoto, Japan.

DIAS Community Forum is held once a year to communicate with existing DIAS users and to reveal the potential users. The forum conducts parallel sessions for each field of use, ideathons, etc., and helps to understand the user requirements of the initiative. In the case of Ideathons implemented last time, we encouraged participation from other platform Initiatives in Japan. Taking this opportunity, we plan to work with these platform Initiatives. To understand the technical feasibility of application development on DIAS, implementation of hackathon for DIAS and other open data is planned in the future.

Metadata Input Camp is held regularly, mainly as a data input cooperator's capacity building once or twice a year.

6. Governance

The initiative is based on the MEXT as a donor, and RESTEC is in charge of planning and promotion, and management of the entire project. Application development support is mainly at the University of Tokyo, and is shared by Kyoto University, Nagoya University, and the National Institute of Informatics (NII). The University of Tokyo is promoting the Water Application Development as a core application on DIAS.

In the DIAS Project Management Office, the two sub-project managers from RESTEC support the project manager (Takashi HONGO, Senior Fellow or Mitsui Global Strategic Institute) to lead promotion of the Initiative.

Several meeting bodies are installed for each function of the Initiative to understand the issues and installing the measures. Discussions of the each meeting bodies are shared and managed by the DIAS PM Office.

The DIAS PM Office set up an advisory board consisting of the following members, and has received advice on the implementation status of the Initiative and the appropriateness of the future plan.

The structure of the Initiative is shown in following figure.

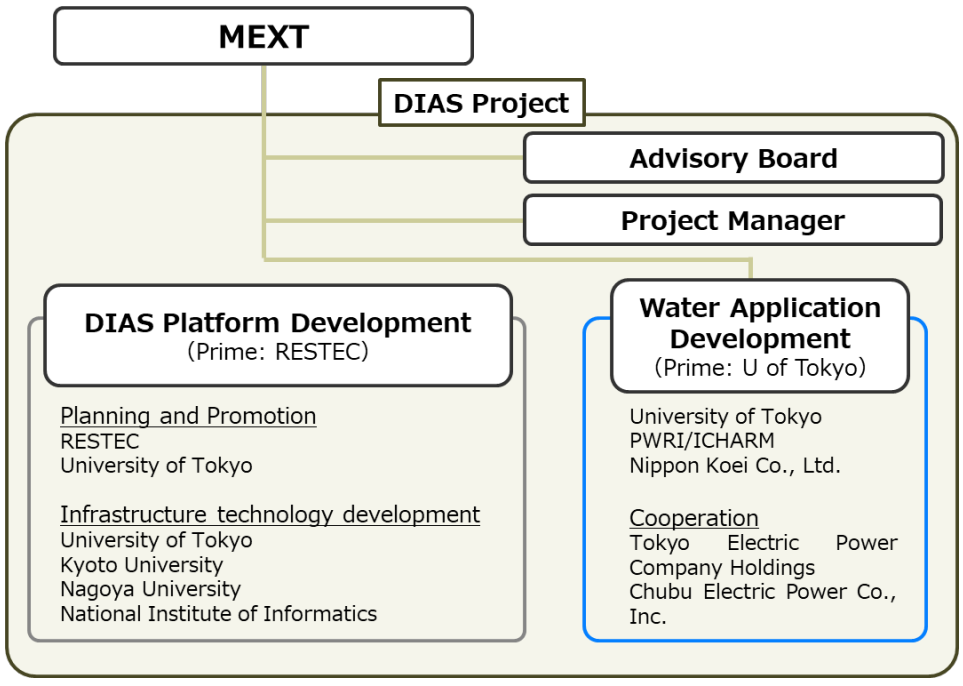

Figure 7. Structure of the DIAS Initiative

7. Resources

A computing environment consisting of an approximately 27 petabytes storage containing public data shown in Section 8 and private data for research, and CPUs and GPUs for analysis and processing are mainly placed to the Komaba Campus of the University of Tokyo and the Chiba Branch of the National Institute of Informatics. Operation including system maintenance is performed by Kyoto University, Nagoya University, and National Institute of Informatics, with the University of Tokyo at the center.

All programs have been implemented as a 100% funded project from MEXT by 2020. After that, the implementation policy and operation system are being examined for the realization of operation that does not depend only on the national budget.

In order to realize the above-mentioned operation that does not depend only on the national budget, introduction of external funds (ex. International cooperation funds etc.), and use charges by private enterprise use (ex. Calculation environment use fee, service fee, IP license etc.) It is considered that the system operation cost will be allocated from the fee etc..

8. Technical Synopsis

DIAS archives a wide variety of global environmental data from satellite observation data to ground observation data and numerical simulation results. These include data to be updated and distributed in real time such as Geostationary satellite data, Rainfall Radar data and so on. Also, the range covered by these data varies from regional data to global data.

DIAS collects the crowd source data and IoT data as well for specific projects.

The lists of open datasets are followed.
https://diasjp.net/en/dias-datasetlist/

Data search for the open datasets are available from following URL.
http://search.diasjp.net/finder?lang=en

Since the data stored in DIAS includes the source data itself, users analyze and process using their own developed software and algorithms on their research themes.

9. Data Policy

At present, it can be used under Open conditions for academic research purposes. The data policy of the details follows that of the data provider. The user who uses it is necessary to perform user registration to DIAS. Users with account registration are allowed to use both satellite data and in-situ data stored in DIAS freely and publicly for academic research purposes only.

As for the results (Datasets or Applications) on DIAS, new data policies and application policies set by developers and researchers are given while respecting the data policy of the source data used.

Metadata about all the open data on DIAS is shared with GEOSS Portal through GEOSS Common Infrastructure (GCI), so it can be searched from GEOSS Portal.

Currently, we are making adjustments including the policy of existing data (including satellite data) so that it can be used for commercial use etc. Although the stored data is basically disclosed to users, it will be decided on a case-by-case basis whether it is free or charged, depending on whether the usage is for research or commercial use.