

# 2020-2022 GEO Work Programme

## Implementation plan-- Global Observation on Delta and Estuary

### 1. Executive Summary

- . **1.1 Title:** Global Observation on Delta and Estuary
- . **1.2 Acronym:** GEO-DE
- . **1.3 Existing category:** Community Activity
- . **1.4 Overview:**

Delta and estuary are the link between the land and the sea, the early settlements for our ancestors and still embrace most of the megacities today. Delta and estuary also provide important ecosystem combining the terrestrial and marine eco-functions, they are the most dynamic interaction of biosphere-hydrosphere-pedosphere. Delta and estuary locate on low-land region along the world-wide coast and are exposed to threats from both land and sea, such as the catastrophic flooding, storm surges, tsunamis as well as the long term impact of global warming and sea level rise. Land uses through history and urbanization have greatly changed the feature of global deltas and estuaries and lead to reduction of these important ecosystems. Reservoir damming in the river catchments led to dramatic decrease of sediment supplies and caused quick coastal erosion in delta and estuary area. Land subsidence, pollution and wetland degradation in the delta and estuary areas are global challenges which need more earth observation (EO) data to support the stakeholder decision-making via local, regional and global scales for sustainable and resilient coastal social-ecological system.

Delta and estuary are the highlight coastal research areas of geo-societies for decades, great efforts have been implemented on the surveys and observations by many countries, research groups and disciplines, but reliable, accurate, comparable, multidisciplinary and timely information on global deltas and estuaries is still not available. Recent advancement in EO data availability and *in-situ* monitoring methods, computing and information technologies provide new opportunities to observe and monitor deltas and estuaries from local to global scales on a regular basis. Varieties of remote sensing sensors and spatial resolution of data and their availability make it possible to monitor deltas and estuaries and to understand their evolution processes under natural and anthropogenic impacts with unprecedented spatial and thematic details.

The goals of GEO-DE are to foster an interdisciplinary and trans-boundary platform for global geo-society to well use global EO data and *in-situ* monitoring information, to better understand the pressures of deltas and estuaries and to provide global reliable information in order to improve sustainability and resilience of social-ecological system in global deltas and estuaries.

- . **1.5 Planned activities**

The following major activities are planned:

- To build dataset of multi-sourced global earth observation data for the past 20years (even longer time series if data is available), together with *in-situ* monitoring information, socio-economic statistical information from selected deltas and estuaries of different continents and climate zones.
- Import and develop proper EO tools to identify the critical parameters for variation and pressure of ecosystem and environment in the delta and estuary.
- To complete change analysis with 5-10 years interval and identify causes, consequences of delta and estuaries ecosystem changes of major deltas and estuaries;
- To identify the vulnerabilities, disaster risk of selected deltas in climate change-based.

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## 2. Purpose

### 2.1 Rationale

Human ancestors chose deltas as settlements for their fertile farm lands and water resources supplied by rivers. Vast sediment and nutrient discharges from rivers make estuaries the most prosperous ecosystems on the earth. Most of the present deltas were formed during the middle and late Holocene and have a history of less than 7000 years, some of them are still in the procedure of continuing growth, young and vulnerable to the natural and anthropogenic pressures. Urbanization in the past centuries has dramatically changes the landform, environment and ecosystem of the deltas and estuaries around the world. Take the example of Shanghai in the Yangtze River (Changjiang River) Delta, the central urban area grew from tens km<sup>2</sup> at the beginning of 1900's to 2650 km<sup>2</sup> in 2019 and population changed from less than 1million to 12millions. Use of groundwater had caused up to 3m land subsidence between 1900 and 1960 in Shanghai. The Three Gauges Dam on the Yangtze River decreased the sediment supplies to the coastal area and changed the evolution of Yangtze River Delta, erosion of coastline and offshore estuary has been detected. Sea level rise and increasing storm frequency and intension lead the delta most vulnerable to global climate changes according to IPCC reports. Land reclamation reshaped the features of delta and estuary and caused serious ecosystem degradation taking the coastal wetland as one of the biosphere indexes. Pollution, eutrophication and hypoxia in the Yangtze estuary and adjacent offshore in the East China Sea raised great attention at the end of last century, terrestrial pollutant control policy conducted by Chinese government along the river catchment and delta area have greatly promoted the marine environments in the last decade. These stories of changes and challenges in the Yangtze River Delta and Estuary can be retold in most of the deltas and estuaries in the world, like the Nile, the Mississippi, the Amazon, the Mekong, the Po, the Rhine, the Yellow River, the Red River and so on, the changes in smaller river deltas and estuaries even faster and more catastrophic.

For decades delta and estuary have caught global attention in the scientific societies, thousands of literatures revealed their development and evolution though time from the point view of geology, geography, hydrology and ecology et al., many international cooperation programs had highlighted the deltas and estuaries, such as LOICZ, S2S and Asian cooperative program such as MegaDelta and DelSeas et al., had tried to build the linkages across disciplines. However, most of these studies focused on either single delta, or short term survey or research on different deltas, either on the land portion or offshore portion With the development global observation tools, more researches with satellite data have revealed the changes of deltas, such as land cover changes, land subsidence, urbanizations, shift of ecosystems, but the relationship between the natural evolution of delta under impact of global changes and impact of human activities are not clear, there is lack of real-time monitoring or observation on the deltas and estuaries to reveal the mechanism of their changes for better forecasting and early warning strategies. A global dataset of reliable, accurate, comparable, multidisciplinary, spatial and temporal information of the world deltas and estuaries are necessary for their sustainable and resilient development. The recent advancement of EO provides opportunity to observe the deltas and estuaries in higher spatio and temporal resolution, integrated information for trans-boundary research and assessment.

### 2.2 Actual and/or planned outputs of the Community Activity and their geographical scope

GEO-DE aims to foster an interdisciplinary and trans-boundary platform for global geo-society to well use global EO data and *in-situ* monitoring information, so as to better understand the pressures of deltas and estuaries, to provide global reliable information for improving sustainability and resilience of social-ecological system of deltas and estuaries in the world.

The following major outputs are planned:

- Dataset of global EO data (all available sensors and resources) for over 5 selected major deltas and estuaries with 5-10 years interval from the past 20years, together with *in-situ* monitoring information and socio-economic statistical information. Asian and European major deltas and estuaries will be the priorities for the first stage.
- Time series changes analysis of major deltas and estuaries based on multiple indicators.
- Demonstration and validation of EO tools for delta and estuary observation and monitoring.
- Building working groups within GEO members for delta and estuary observation.

• **2.3 Actual and/or intended users of the outputs and the expected types of decisions these outputs are expected to inform.**

GEO-DE will have a huge beneficiary groups, users will come from governments and non-governmental organizations and academic and scientific communities. National government and coastal cities can use this data for spatial planning, resource management and environment preservation, risk assessment and early warning of disasters.

### **3. Background and Previous Achievements**

Delta and estuary have always been the critical elements of GEO Flagship, Initiative programmes and activities concerning the ecosystem, environment, wetlands, climate change, disaster risk assessment for their important function in the earth ecosystem as well as the global economy and human population. But a specific GEO activity on delta and estuary hasn't been formed. Enormous efforts of observation, survey and in-situ monitoring activities were conducted in many countries across the world, but the variety of data collection, methodologies, indicators make it hard for global comparison and assessment, GEO-DE will play an important role in GEO for taking delta and estuary as a specific ecosystem, demonstration of sustainable development and hotspot of climate changes and the Anthropocene processes.

Cooperation on mega-delta in Asian countries have been conducted through regional cooperative programmes, especially CCOP (Coordinating Committee for Geo-science Programmes in East and Southeast Asia) had funded several topic-related projects among the member countries including China, Japan, Korea, Vietnam, Thailand et al.

Recently China government initiated several national development plans with delta and estuary as the key areas, such as the Guangdong-Hong Kong-Macao Greater Bay Area (in the Pearl River Delta and Estuary), the Integration of the Yangtze River Delta (Yangtze River Delta and Estuary) , Circum Bohai Sea Economic Zone (the Yellow River, Haihe River and Liaohe River deltas and estuaries), a series of national scientific programmes were launched for supporting the planning, ecosystem restoration, environment protection and resources development. EO is the core topics of these programmes. A dataset and series of atlas were compiled with long time series remote sensing data (such as Landsat series, ZY3-02, GF-2, GF-4, InSAR), survey data (geological and geophysical mapping data, topography mapping data, surface and groundwater quality) and *in-situ* monitoring data (coastal erosion, land subsidence, water quality, green-house gas emission et.al), carrying capacities and suitability assessment on resources and environment were conducted and the reports were delivered to Chinese central government and local authorities for supporting space planning and construction of ecological civilization. These previous achievement and methodologies can be practiced and improved in other delta and estuary in the world through the cooperation within GEO.

### **4. Key Activities**

GEO-DE aims to foster an interdisciplinary and trans-boundary platform for global geo-society sharing all resources information in the delta and estuary area, including EO data, *in-situ* monitoring data and socio-economy statistic data, the changes through history of different development periods will be analyzed base on multi-factors data, to better understand the causes and pressures of deltas and estuaries, assess the disaster risk and build model of climate change adaptation and early warning for disasters, GIS database will provide basic reliable information for improving sustainability and resilience of social-ecological system.

Representative deltas and estuaries will be selected from different continent based on their geological and geographic features, climate zones, development history, data available and pressures for climate changes and anthropogenic activities.

#### **4.1 Mapping delta and estuary**

Multi-source EO data will be collected and processed for the selected deltas and estuaries, including the land cover (urbanization, wetland, forests, water space), DEM of elevation, meteorology (precipitation, evaporation, temperature, air particulate matter ), water quality and infrastructures et al, data are not limited to the delta and estuary, river catchment and adjacent offshore should be included as well. *In-situ* monitoring information (surface water, groundwater, land subsidence et al.) and socio-economic statistical information (population, economy, infrastructure, loss of disasters) will be

collected through working partners too.

#### **4.2 Advanced tools for critical parameter and stress identification**

Advanced EO tools will be imported for identify peculiar stress in delta and estuary, e.g., the land subsidence, air, soil and water pollution and ecosystem degradation et al.

#### **4.3 Changes and consequences analysis**

To complete change analysis with intervals of 5-10 years in the past 20years, even longer time series if data is possible, post-disaster analysis is necessary, and to identify causes, consequences and pressures of major deltas and estuaries.

#### **4.4 Modelling for planning and early-warning**

Tools of modelling for environment impact assessment of climate changes and anthropogenic activities, sustainable and resilient delta and estuary management planning, early warning for crisis and adaptation strategy planning, will be practiced in the programme implementation. Modelling results will support the decision-making for government, local communities and other stakeholders, as well as serve the goals of GEO.

#### **4.5 data portal construction, maintain and service**

GEO-DE data portal will be established based on the new database and GIS technology, the Geo-Cloud of China Geological Survey will provide technical and infrastructure supports. The database will comply with the GEOSS Data Sharing principles and GEOSS Data Management Principles to ensure the open access for the GEO communities.

#### **4.6 Capacity building**

Capacity building will be realized through trainings and workshops, and active interaction and cooperation activities among the partners, young scientists and graduate students will be welcome.

#### **4.7 yearly activities plan**

Above-mentioned key activities will be organized with yearly implementation activities:

**Year 2020:** Partnership building, programme activities **4.1, 4.2, 4.5, 4.6**, participating GEO activities.

**Year 2021:** participating GEO activities, programme activities **4.1, 4.2, 4.3, 4.5, 4.6**, communication to local communities.

**Year 2021:** GEO activities, **4.1, 4.2, 4.3, 4.4, 4.5, 4.6 and** programme report.

### **5. Relationship to GEO Engagement Priorities and to other Work Programme Activities**

The GEO-DE dataset will serve as an integrated GIS database for a number of GEO engagement priorities and to other work programme activities, addressed as following:

#### **5.1 UN SDGs targets**

Deltas and estuaries host the world largest population residences, the main food supplies from agriculture and fishery, the busiest land and marine transport infrastructures, GEO-DE has the opportunity and potential to contribute to most UN SDGs targets and that the scope and nature of delta and estuaries create opportunities to leverage some goals in particular:

- SDG 6: "Water-related Ecosystem" "Restoration of Ecosystem"
- SDG 11: "Inclusive, Safe, Resilient and Sustainable Cities and Human Settlements"
- SDG 13: "Climate Change-related Planning and Management"

#### **5.2 Paris Agreement pillars**

Deltas and estuaries geographic low elevation make them vulnerable to climate changes, e.g. sea level rises, flooding and storm harsh wave. Drought can easily damage the water-related ecosystem. GEO-DE is highly related to the Paris Agreement identified by GEO Climate, in particular provide dataset for:

- Article 7: Formulate and implement national adaptation plans (NAPs).
- Article 8: Risk assessment of loss and damage, Resilience of communities, livelihoods and ecosystems.

#### **5.3 Sendai framework**

Damages caused by typhoons (or cyclones and hurricanes) in deltas and estuaries caused billions

dollars economy losses and large number of casualties each year. GEO-DE aims to provide integrated EO data for support disaster risk reduction through capacity building on early EO-based warning modeling, and post crisis assessments, as well as providing accurate and timely GIS information for rescue and evacuation.

#### **5.4 Initiatives**

GEO-DE broadly links to the GEO flagship and initiatives programmes concerning of sustainable urban development, ecosystem sustainability, infrastructures and transport management, water resources management. There will be plenty of interaction activities and cooperation between GEO-DE and other GEO activities in the future.

#### **6. Governance**

. Dr. Ping YIN (E-mail: pingyin@fio.org.cn), from Qingdao Institute of Marine Geology, China Geological Survey (CGS), will lead the role of activity coordinator by participating GEO related activities and updating the implementation plan according to the review panel feedback and annual activities operation, seeking for funding or in-kind contribution from all resources to realize this implementation plan, organizing workshops and seminars, coordinating the GEO-DE database construction and services.

Dr. Baikun YAN (E-mail: 55561161@qq.com), from China Aero Geophysical Survey and Remote Sensing Center for Natural Resources (AGRS), will coordinate the scientist teams to collect and interpret EO data with advanced EO tools, will develop models for DE vulnerability analysis, risk assessment and early warning.

Dr. Dhiti Tulyatid (E-mail: dr.dhiti@ccop.or.th), from Technical Secretariat of CCOP (CCOP-TS) , will introduce this implementation plan into CCOP themes, and coordinate CCOP member countries participating the GEO-DE activities, capacity building and technology transfer of EO can be conducted through workshops, annual conference and thematic meetings organized by CCOP-TS and member countries.

#### **7. Data Policy**

GEO-DE complies with the GEOSS Data Sharing Principles and applies the GEOSS Data Management Principles to all data uploaded to GEO-DE database. There will be open exchange of data, metadata and products shared within GEOSS and GEO-DE participants. All shared data, metadata and products will be freely available for all activity members, free of charge or no more than cost of reproduction will be encouraged for research and education.