

# Global Urban Observation and Information, 2020-2022

## Implementation Plan

### 1. Executive Summary

- Full title of the Initiative: [Global Urban Observation and Information, 2020-2022](#)
- Short title or acronym: [GUOI 2020](#)
- Existing or proposed category: GEO Initiative
- Overview:

GUOI 2020 intends to improve urban monitoring and assessment by developing a series of satellite based essential urban variables and indicators of sustainable cities through international cooperation and collaboration, to provide datasets, information, technologies to pertinent urban users in World Bank, UN, Africa, South America, and planning and environmental management agencies in other developing countries, and to support UN SDG Goal 11: Make cities inclusive, safe, resilient and sustainable.

The pertinent government agencies that would most likely use our datasets include city authorities and resilient offices, departments of urban and regional planning, environmental management, natural resources, metropolitan transit authority, and office of sustainability, and regional statistics. These agencies need to use the datasets to obtain information about urban land use/land cover, urban form and growth patterns, infrastructure and transport needs, ecosystems and biodiversity, human health, thermal comfort, food security, and socioeconomic development. Further, the World Bank Platform for Urban Mapping and Analysis can be greatly benefited from the datasets, products, and services that this project offers. For scientific community, GUOI 2020 will provide new knowledge on global urbanization process and innovations on urban observation.

While some activities are extensions of the GEO SB-04 and GI-17 activities, others are proposed anew. These activities of different organizations and countries are coalesced as one single GEO initiative through collaborative and affiliated projects, annual symposia, international summer school, joint field works, publications, and coordinated user engagement efforts. GUOI 2020 will generate various data products of global urban areas using Earth Observation (EO) data, provide EO-based urban data services through various systems and tools, develop new models and algorithms to assess and monitor urban environments, create a better knowledge of cities and to develop essential urban variables and indicators for sustainable cities for SDG Goal 11.

Highlights of activities for 2020-2022 include: (1) Megacities Observation and Monitoring (MOM) program; (2) Continued generation of Global Human Settlement Layers; (3) A Virtual Global Urban Remote Sensing Laboratory; (4) Impervious Surface Mapping in Tropical and Subtropical Cities project (Asia, Africa, and South America); (5) Establish a Global Institute of Sustainable Cities (GISC); and (6) Organize annual GEO Global Urban Observation symposium, joint field works, and international summer school.

The most innovative aspects of this GEO initiative are:

- A group of stakeholders and interested partners from government, municipalities, education, research institutes, and data services providers pursue common objectives;
- Enable a broad variety of detailed activities in support of the GEO's overall strategic goals;
- Leads and contributors are well represented from both developed and developing countries;

- Train and educate students and young researchers worldwide to become tomorrow’s leaders in Earth Observation technologies and applications;
  - Disseminate GEO ideas and goals through symposia, summer schools, joint field works, and publications;
  - Identify and exploit synergies of resources in R&D as well as applications and benefits;
  - Expand the impacts of SB-04 and GI-17 developments by specifically addressing cities in developing countries;
  - Facilitate joint research projects and broaden the knowledge on global urban remote sensing; and
  - Provide data that can be used by policy- and decision-makers for addressing SDG Goal 11 and its targets, and for developing climate change mitigation and adaptation plans for urban areas, public health applications, urban hazards, and indicators for sustainable cities.
- Planned Activities (summary of Tasks from Table C below)
    - (1) Develop a series of **satellite based essential urban variables** and indicators of sustainable cities to support UN SDG Goal 11 through international cooperation and collaboration.
    - (2) Establish a **Global Institute of Sustainable Cities (GISC)** - Explore EO as an enable technology for development of sustainable cities and for supporting GEO’s objective on urban resilience and coastal resilience by providing EO methods and technologies, supplying objective information on the footprint of global urbanization and assisting in the development of indicators for sustainable cities to support the UN’s sustainable development goals.
    - (3) **Megacities Observation and Monitoring (MOM)** program: Expanded from the Global Urban Supersites Initiative under GEO SB-04 and GI-17. These projects focus on global urbanization of megacities and providing data sets for municipalities for megacities worldwide.
    - (4) Continued generation of **Global Human Settlement Layers** at various international and national levels and seek synergies among them. The main partners of this program include NOAA, USGS, DLR, University of Pavia, KTH Royal Institute of Technology Sweden, University of Tokyo, and Indiana State University.
    - (5) Implementing a **Virtual Global Urban Remote Sensing Laboratory** through joint projects: The main objective is to develop an online tool for acquiring, processing, visualizing, and sharing of urban data sets.
    - (6) Continuing joint projects on **Impervious Surface Mapping in Tropical and Subtropical Cities - ISMiTSC** (Asia, Africa, and South America): This initiative focuses on urban mapping and providing datasets and EO technology services to developing countries.
    - (7) Organize **Annual GEO Global Urban Observation Symposium**.
    - (8) Create an annual **International Summer School** to train and educate students and young researchers worldwide, which may be held in conjunction with **Joint Field Work in Selected Cities/Regions**, during a GEO event.
    - (9) **Collaboration with IEEE GRSS and ISPRS** for capacity building and to showcase and **disseminate research results**.
    - (10) Seek **synergies with other GEO flagships/initiatives**.
  - Point of Contact: Dr. Qihao Weng, Indiana State University, Email: [qweng@indstate.edu](mailto:qweng@indstate.edu).

## 2. Purpose

### 2.1. Rationale for the Initiative

- GEO advocates the value of Earth observations, engage communities and deliver data and information in support of **Sustainable Urban Development** by assisting in the development of resilient cities and assessment of urban footprints; in order to make cities and human

settlements inclusive, safe, resilient and sustainable through identifying economic externalities, managing environmental, climate and disaster risks, and building capacity to participate, plan and manage based on objective information regarding urban development.

The objectives and activities of GUOI 2020 are to support GEO's objective on **Sustainable Urban Development**. In particular, GUOI 2020 supports the development of urban resilience (including coastal resilience) by supplying objective data and information on the footprints of global urbanization and cities, developing essential urban variables and indicators for sustainable cities in support of UN's SDG Goal 11, and developing innovative methods and techniques in support of effective management of urban environment, ecosystems, natural resources and other assets, and the adaptation and mitigation of urbanization adverse impacts as well as climate change.

## 2.2. Actual and/or planned outputs of the Initiative and their geographical scope

- Date sets: Urban footprint/urban extent, urban land cover change, human settlement datasets, urban environment variables (land surface temperature, impervious surface, green space, nighttime light, and so on) at global, regional, and national scales generated by several groups.
- Models, algorithms and Services:
  - (1) Spatio-temporal Adaptive Data Fusion Algorithm for Temperature mapping (SADFAT) – Merge coarse resolution and medium resolution satellite image data to generate daily medium resulting data;
  - (2) DELTA algorithm to reconstruct consistent, daily land surface temperature data at Landsat resolution based solely on Landsat imagery;
  - (3) Object-based Urban Thresholding method for NTL image data (NTL-OUT) – Calibrate inconsistent time-series DMSP/OLS NTL image data to map and update large-scale urban areas; and
  - (4) the NOAA System of real-time, operational, 5 minute monitoring of land and air surface temperature and humidity for cities and the offered service called EXTREMA (Emergency notification system for extreme temperatures, [www.extrema.space](http://www.extrema.space))
- Information about existing data gaps in integration of global urban observations with (i) data characterizing urban ecosystems, thermal environment, geohazards, air quality, and carbon emission; (ii) indicators of population density, environmental quality, and quality of life; (iii) social and economic data; and (iv) patterns of human, environmental and infectious diseases.
- A set of "indicators" that quantify the status and trends of cities and human settlements and support the urban sustainable development goal that is being planned for at the UN.
- Systems and tools: (1) Thematic Urban Observation Hub (TUrbO-Hub) - Platform for the Mapping, Analysis, Monitoring and Assessment of Urban Development; (2) SAR4Urban: Provide data sets of selected cities from ESA radar imagery to the users of the cities; and (3) Urban Extractor: to map global urban extent at 30m resolution using ENVISAT or Sentinel-1 SAR data; (4) EO4Urban - Urban extent maps over 10 cities experiencing rapid urbanization; (5) Sentinel4Urban – Urban extents extraction using Sentinel data; (6) Dragon 4 - Earth Observation Based Urban Services for Smart Cities and Sustainable Urbanization.
- Publications: Journal special issue on environmental sustainability in South America, Asia-Pacific region, and Africa, and a new book "*Geospatial Big Data for Sustainable Cities*".

- Assessment of the developed tools, systems, and models by decision makers and user partners.
- Annual International Summer School; Joint field works in selected cities or regions; and Annual GEO Global Urban Observation symposium.
- Invited sessions at JURSE and EORSA workshop.

### 2.3. Actual and/or intended users of the outputs and the expected types of decisions

Intended users:

- Local/regional/country scales
  - Involved institutions (meaning users) in the cities (urban and spatial planning).
  - City Authorities (Climate Change departments, Urban planning Departments, Resilient Offices)
  - Local/regional/national environment and planning agencies.
  - EU directorate general regional policy (DG REGIO)
  - Energy suppliers
- Global scale
  - UN-Habitat
  - World Bank
  - Science community (e.g. urban climate modelers, coastal managers, epidemiologists)
  - Education
  - International City Networks

### 2.4. Expected outcomes, impacts and beneficiaries from adoption of the outputs from the Initiative

- Coordination of worldwide activities for urban monitoring, forecasting, and assessment, with new projects and products contributed and connected to GEOSS, and foster international collaboration on Earth Observation.
- Users/stakeholders include the World Bank, UN Habitat, local users, and etc. The World Bank (Sustainable Development Unit) is using the radiance VIIRS products to rate the success and longevity of electrification projects in India, Vietnam and Indonesia.
- Developing global standards and requirements for the acquisition and validation of products and developing a data repository for megacities, and a Global Urban Remote Sensing Laboratory (GURSLab) aiming at developing an on-line processing (urban areas extraction, basic image processing, and key metrics), visualizing, and data sharing tool.
- Supporting climate change impacts on urban areas via association with the U.S. National Climate Assessment.
- EXTREMA aims to improve the resilience city population to extreme temperature events (heatwaves and cold spells). Such events can cause many excess deaths and are projected to become more pronounced due to climate change. Increased awareness induces self-protective behaviors that in turn reduce the loss of life.
- Develop global metrics supporting the new urban agenda, the Post-2015 processes on sustainable development goals (SDGs), the Paris Climate Change, and the Sendai Framework for Disaster Risk Reduction.
- Train and educate students and young researchers worldwide to become tomorrow's leaders in Earth Observation technologies and applications.

### 3. Background and Previous Achievements

- Global Urban Supersites Initiative: To estimate urban extent, change detection, and assess risks associated with natural disasters, air/water qualities, and health hazards; 8 megacities selected (Los Angeles, Atlanta, Mexico City, Athens, Istanbul, Sao Paulo, Beijing, Hong Kong); Website incl. data repository launched ([www.indstate.edu/cuec/UrbanSupersites/home.html](http://www.indstate.edu/cuec/UrbanSupersites/home.html)). Global Urban Supersites have recently been funded through two international projects:
  - ❖ “Earth Observation for Global Urban Services” (EO4Urban)”, ESA Invitation To Tender (ITT) AO/1-7829/14/I-NB DUE – Innovators III, 1/1/2015 – 12/31/2017.
  - ❖ “Improving the Estimation of Impervious Surfaces Using Optical and Polarimetric SAR Data in Humid Subtropical Urban Areas”, Hong Kong Research Grants Council, 1/1/2016-12/31/2017.
- A Global Urban Remote Sensing Laboratory (GURSLab), aiming at developing a tool for online processing, visualizing, and sharing of urban data sets. This project has been recently funded with €999,870, entitled “Thematic Urban Observation Hub (TUrbO-Hub) - Platform for the Mapping, Analysis, Monitoring and Assessment of Urban Development,” PI, Thomas Esch, DLR, with participation of several co-Leads of SB-04, through ESA Invitation To Tender/1-7870/14/I-NB Thematic Exploitation Platforms (TEP) program, 1/1/2015 – 12/31/2016.
- Six groups have generated Global Human Settlement Layers using satellite data (see the previous section).
  - ❖ The US (NOAA National Geophysical Data Center) has produced global radiance calibrated VIIRS low light imaging products: 1) nightly, 2) monthly, and 3) annually. NGDC is still developing algorithms for producing research quality nighttime lights, with background noise, fires, and aurora removed. The World Bank (Sustainable Development Unit) is using the radiance VIIRS products to rate the success and longevity of electrification projects in India, Vietnam and Indonesia;
  - ❖ The European Commission (JRC) has contributed its whole image repository for information extraction (Global Human Settlement Layer (GHSL) project). This data (derived from fine scale optical images) cover 100's of millions of km<sup>2</sup> with resolution ranging from 0.5 to 100 m;
  - ❖ The Global Urban Footprint (GUF), the Global Urban Area Map (AGURAM), and the Global Urban Extent, generated by Germany Space Agency (DLR), include user groups of the World Bank Group, the European Environment Agency (EEA), DG Regio of the European Commission, the International Society of City and Regional Planners (ISOCARP) etc. Moreover, DLR has produced a time-series analysis (1975-2010) describing the spatiotemporal development of 26 mega-cities, also setting up a global data base of binary settlements masks (Global Urban Footprint) derived from SAR data of the TanDEM-X mission (grid cell size: ~50x50 m);
  - ❖ Sweden (KTH) and Italy (University of Pavia) have developed an “Urban Extractor” to map global urban extent at 30m resolution using ENVISAT or Sentinel-1 SAR data;
  - ❖ Japan (GEO Grid/AIST, University of Tokyo) has developed the ASTER Global Urban Area Map (AGURAM). 3734 cities of more than 0.1 million people urban area have been mapped using ASTER (15m). Gaps will be filled using PALSAR data.
  - ❖ U.S. Geological Survey has recently released the National Land Cover Database (NLCD) 2011 products, including impervious surface changes between 2001-2006, and 2006-2011. The NLCD urban land product has been widely used by many scientific studies including land cover change and climate change impact in the United States and around the world. Many GEO participants are the users of NLCD products.
- Reference/Text book “Global Urban Monitoring and Assessment through Earth

Observation” (published in 2014) and “Remote Sensing for Sustainability” (published in 2016), with contributions from GUOI participants.

- Annual workshop/symposium focusing on GUOI (IGARSS 2018, EORSA 2018, AAG 2017-2019).
- The alpha version of the Global Human Settlement Layer (GHSL) produced by Landsat data 1975-2014 has been released. The user list includes circa 30 research groups inside World Bank, UN agencies, European Commission, several national space agencies and other governmental and academic entities.
- EXTREMA offers real time surveillance and evaluation of heat health risk during the summer and heatwaves. EXTREMA is a tool for City Authorities for central management of heat waves and Citizens/Visitors for personalized heat risk assessment. It uses real-time satellite data, along with other model and city-specific data to estimate the temperature, humidity, and discomfort index for every square kilometer in the city. Through the EXTREMA mobile application, citizens receive a personalized heat stress risk for their current location and recommendations on measures to reduce their risk. Recommendations are based on those issued by the World Health Organization (WHO) or provided by City authorities. EXTREMA has been launched in Paris, Athens and Rotterdam (2018) and will be launched in Milan and Lisbon (2019). It is expected to scale up in 2020-2022. .
- Students and young researchers worldwide attracted to GEO Urban Symposia and various activities through the GEO Trust Fund.
- The International Program on Global Urban Observation and Public Health (IPUP) was initiated in Changsha, China, in June 2014, aiming at monitoring global urban environment and public health concerns from space and with in situ measurements. This initiative has recently been proposed for funding through an international cooperation project by the Ministry of Science and Technology of China.

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

##### 4.1. UN SDG targets and/or the measurement of SDG indicators

Planned activities (1)-(6) are designed for the development of satellite based essential urban variables and indicators of sustainable cities through international concerted works. These activities support SDG Goal 11. See details in the Table below.

<b>Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable</b>	
	11.1.1 Proportion of urban population living in slums, informal settlements or inadequate housing
11.3 By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries	11.3.1 Ratio of land consumption rate to population growth rate
	11.3.2 Proportion of cities with a direct participation structure of civil society in urban planning and management that operate regularly and democratically
11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management	
	11.6.2 Annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (population weighted)
11.7 By 2030, provide universal access to	11.7.1 Average share of the built-up area of

safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities	cities that is open space for public use for all, by sex, age and persons with disabilities
11.a Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning	11.a.1 Proportion of population living in cities that implement urban and regional development plans integrating population projections and resource needs, by size of city
11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels	11.b.1 Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015-2030 <sup>d</sup>
11.c Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials	11.c.1 Proportion of financial support to the least developed countries that is allocated to the construction and retrofitting of sustainable, resilient and resource-efficient buildings utilizing local materials

#### 4.2. Paris Agreement pillars

The main goal of GUOI 2020 is to investigate how currently available remotely sensed data from various satellite platforms and in-situ observations can be optimized for use to develop essential urban variables and indicators over global cities, which will be crucial for climate assessment over urban areas. We aim at the creation of new methods and algorithms to develop data products and to advance the knowledge of urban warming and its impacts on human health and mortality, the environment (including urban heat island, heat wave, evapotranspiration, energy consumption, water supply and demand, environmental and human health) and the productivity and sustainability of human and natural ecosystems in cities and their hinterlands. The proposed activities will support the “adaptation” and “mitigation” pillars of the Paris Agreement. Because our strategic application regions focus on Asia, Africa, and South America, GUOI 2020 will also contribute to the pillar of “Capacity Development / Technology Transfer”.

#### 4.3. The Sendai Framework targets

One of the outputs of GUOI 2020 is to provide information about existing data gaps and integration methods between global urban observations with (1) data characterizing urban ecosystems, thermal environment, geohazards, urban anthropogenic hazards (e.g. heat wave), air quality, and carbon emission; (ii) indicators of population density, environmental quality, and quality of life; (iii) social and economic data; and (iv) patterns of human, environmental and infectious diseases. Through this output, GUOI 2020 will help the Sendai Framework targets by assessing, modeling and predicting urban geohazards and human hazards.

### 5. Stakeholder Engagement and Capacity Building

#### 5.1. Description of some key organizations and stakeholders at the international level

The **German Aerospace Center**, abbreviated **DLR**, is the national center for aerospace, energy and transportation research of Germany. Its headquarters are located in Cologne and it has multiple other locations throughout Germany. The DLR is engaged in a wide range of research and development projects in national and international partnerships. In addition to conducting its own research projects, DLR also acts as the German space agency. As such, it is responsible for planning and implementing the German space programme on behalf of the German federal government. As a project management agency, DLR also coordinates and answers the technical and organizational implementation of projects funded by a number of German federal ministries.

The **National Observatory of Athens (NOA) in Greece**, apart from being the oldest Greek Research Institution with a constant presence and activity in Science at international level as well as in the Greek society for 170 years (since 1842), is a Research Centre active in Space Sciences and their applications with remarkable achievements. NOA with its three Institutes (Astronomy, Astrophysics, Space Applications & Remote Sensing IAASARS; Environmental Research and Sustainable Development IERSD; Geodynamics GI), its highly-skilled human resources and the important infrastructure obtained over the last two decades, plays an important role in international space science activities and has a leading role in the national efforts for presence in the European Space Sector. NOA also constitutes a critical national link with the European Space Agency (ESA) and other relevant organizations and bodies within the European Union. IAASARS/NOA is one of the three NOA Institutes (formerly two institutes merged earlier in 2012) currently has a permanent staff of 30, plus 40 contracted scientists. IAASARS/NOA has been actively involved in Space Sciences, Space applications and Earth Observation with remarkable achievements in leading research, and operational activities in the context of EU flagship programs/initiatives namely COPERNICUS, GALILEO, GEO, and GEOSS.

**KTH Royal Institute of Technology, Sweden**, has been collaborating with the UN Habitat to support its work on development of methodology for monitoring UN 2030 Sustainable Development Goal (SDG) 11, indicator 11.3.1 and 11.7.1. At the local and regional levels, KTH has been working closely with the planning offices at the City of Stockholm and the Stockholm County Administrative Board on their needs to monitor changes automatically with EO data and to support sustainable planning. Stockholm is the fastest-growing capital in Europe. Because of accelerating urbanization, the Greater Stockholm area will more than double in population by 2045, to 4.5 - 5 million people. Therefore, it is crucial to continuously monitor the changes so that the geographic databases are kept up to date to support sustainable planning.

**Nanjing University, China**, has conducted systematic research on urban remote sensing from local to national scales. The activities related to GUOI mainly include: 1) development of algorithms and tools for extracting urban extent, classifying urban land cover, modeling urban physical environment and supporting urban planning using multi-source earth observation data; 2) typical uses and services of urban observation information to urban planning and management in the Yangtze River Delta urban agglomeration; 3) dynamic monitoring of urbanization, environment change and climate change for sustainable development; 4) involvement to the MOST-ESA Dragon project focusing on smart cities.

**National Institute of Urban Affairs (NIUA), India**, is a premier institute for research, capacity building and dissemination of knowledge for the urban sector in India. It conducts research on urbanization, urban policy and planning, municipal finance and governance, land economics, transit oriented development, urban livelihoods, environment & climate change and smart cities. The institute was set up to bridge the gap between research and practice, and to provide critical and objective analyses of trends and prospects for urban development and also support the Ministry of Housing and Urban Affairs in its program planning and implementation. NIUA has assisted in policy



formulation and programme appraisal and monitoring for the national governments, state governments, multilateral agencies and other private organizations.

## 5.2. Strategy for engaging stakeholders in the co-development / co-production of the Initiative

Five groups have generated Global Human Settlement Layers using satellite data:

- The US (NOAA National Geophysical Data Center) has produced global radiance calibrated VIIRS low light imaging products: 1) nightly, 2) monthly, and 3) annually. NGDC is still developing algorithms for producing research quality night-time lights, with background noise, fires, and aurora removed. The World Bank (Sustainable Development Unit) is using the radiance VIIRS products to rate the success and longevity of electrification projects in India, Vietnam and Indonesia;
- The Global Urban Footprint (GUF), the Global Urban Area Map (AGURAM), and the Global Urban Extent, generated by Germany Space Agency (DLR), include user groups of the World Bank Group, the European Environment Agency (EEA), DG Regio of the European Commission, the International Society of City and Regional Planners (ISOCARP) etc. Moreover, DLR has produced a time-series analysis (1975-2010) describing the spatiotemporal development of 26 mega-cities, also setting up a global data base of binary settlements masks (Global Urban Footprint) derived from SAR data of the TanDEM-X mission (grid cell size: ~50x50 m);
- Sweden (KTH) and Italy (University of Pavia) have developed an “Urban Extractor” to map global urban extent at 30m resolution using ENVISAT or Sentinel-1 SAR data;
- Japan (GEO Grid/AIST, University of Tokyo) has developed the ASTER Global Urban Area Map (AGURAM). A total of 3734 cities of more than 0.1 million people urban area have been mapped using ASTER (15m). Gaps will be filled using PALSAR data.
- U.S. Geological Survey has recently released the National Land Cover Database (NLCD) 2011 products, including impervious surface changes between 2001-2006, and 2006-2011. The NLCD urban land product has been widely used by many scientific studies including land cover change and climate change impact in the United States and around the world. Many GEO participants are the users of NLCD products. USGS will finish NLCD 2016 update and will release the product in spring, 2019. The product will provide developed impervious surface and change from 2001 to 2016 in every five years in the United States. USGS has also initiated a project named Land Cover Monitoring Assessment and Projection (LCMAP) that focuses on using the long-time Landsat record to mapping, monitoring, synthesizing, and understanding the complexities of land use, cover, and condition change. LCMAP will provide annual land change product from early 1980s to the current. The product will provide the long-time urban land cover change in extent and associated land cover transitions. LCMAP will also produce a long-time land surface temperature change using Landsat Analysis-ready-Data (ARD). The dataset will be used to analyze urban thermal feature change to monitor thermal condition in urban areas.
- 100 Resilient Cities: Several city authorities are using EXTREMA services on extreme temperature events in Cities. For this service NOAA has become platform partner in 100 Resilient Cities network, pioneered by Rockefeller Foundation, and is also collaborating with C40 and iCLEI international city networks. For the period 2018-2019, EXTREMA was funded by European Commission General Directorate on Civil Protection and Humanitarian Aid (DG-ECHO).

These data sets and services are used widely by decision-makers to better understand of environments, resources, and ecosystems worldwide and the scientific community for studies of urban environments and impacts of urbanization.

### 5.3. Current and/or planned activities to engage stakeholders and/or strengthen individual, organizational and/or institutional capacity and the expected outputs and outcomes of these activities

Below are four examples:

EXTREMA aims to scale up to numerous cities and millions of users. This will be achieved through international city networks together with communication plans for the authorities to inform the citizens about EXTREMA mobile application to assess their personal heat health risk.

Automatic method and tools for continuous urban change detection using EO time series data are being developed and will strengthen the capacity of the City of Stockholm and the Stockholm County Administrative Board to monitor changes effectively. The method and tools will also be available to the UN Habitat for use in monitoring land consumption rate. This will strengthen UN Habitat's capacity to monitor land consumption rate efficiently.

The urban observation outcomes will be used to support the development of the Yangtze River Delta urban agglomeration under the National Plan on New Urbanization of China, by providing thematic information related to urban extent, urban land use, urban environment variables and urban evolution to local government agencies.

Within the framework of The Digital Belt and Road Program (DBAR) of Chinese Academy of Sciences, urban extent, urban land cover and urban environment variable datasets will be delivered to local stakeholders in cities along the Belt and Road region. The geospatial data and information will be used in conjunction with local environmental, social and economic data to support implementation of sustainable development goals in major cities along Belt and Road region.

### 5.4. Current and/or planned activities to strengthen the capacity of the participants in the Initiative for successful implementation of the Initiative.

To ensure the project making progress in a timely manner, we plan to have a quarterly tele-conference. Newsletters will be sent to the leads and contributors from the office of Project Coordinator.

Physical meetings of leads and contributors will be scheduled at annual GUOI symposium. During a physical meeting, a draft annual Progress Report will be discussed, so that progress towards the defined targets of the previous year can be assessed, and planning for next year's activities would be made.

We plan to send at least one representative to annual GEO Work Programme Symposium and if feasible to each GEO Plenary. Regular (e.g., Quarterly) reports will be sent to the participating organizations, GEO Programme Board (PB) and GEO Secretariat.

## 6. Governance

### 6.1. Organizational structure

The project will be managed by the Project Coordinator in close collaboration with two distinct groups having responsibility on the technical management and implementation (Project Technical Committee - PTC) and the project progresses and directions (Advisory Board, AB). PTC consists of all contributors of GUOI 2020. The Project Coordinator is assisted by two graduate students, who have dedicated their research to global urban observation.

## 6.2. Project coordinator and supporting organization

Dr. Qihao Weng, Indiana State University

Dr. Weng is the Lead/Coordinator of GEO Global Urban Observation and Information Task/Initiative since 2012, and also serves as the point of contact.

The supporting organization is Indiana State University, specifically, Center for Urban and Environmental Change.

## 6.3. Advisory/steering committee

An Advisory Board (AB) has been set up to provide expertise and advice to the consortium. The AB will consist of six members who have confirmed their participation in GUOI 2020.

AB Member	Organization (Country)	Expertise relevant to GUOI 2020
Dr. Dale A. Quattrochi	NASA Marshall Space Flight Center (USA)	Dale Quattrochi is a Senior Research Scientist in NASA. His research interests focus on the application of thermal remote sensing data for analysis of heating and cooling patterns across the diverse urban landscape. He is also conducting research on the applications of geospatial statistical techniques, such as fractal analysis, to multiscale remote sensing data.
Prof. Paolo Gamba	University of Pavia (Italy)	Paolo Gamba is a Full Professor of Telecommunications at the University of Pavia, Italy, and the President of IEEE GRSS. His current research interests include remote sensing data fusion for urban applications. He is the former Editor-in-Chief of IEEE Geoscience and Remote Sensing Letters.
Dr. Christopher Elvidge	National Oceanic and Atmospheric Administration (NOAA; USA)	Chris Elvidge leads the Earth Observation Group (EOG) in the Solar and Terrestrial Physics Division. His group has responsibility for the DMSP (Defense Meteorological Satellite Program) long-term archive. DMSP is unique for its ability to collect low light imagery of the Earth at night especially useful for monitoring urbanized areas.
Dr. George Xian	United States Geological Survey (USA)	George Xian is working at the USGS Earth Observation and Science Center as a science leader for the land cover change classification and impact analysis. He has developed models for the National Land Cover Database production. His current research focuses include land cover-urban, vegetation dynamics in semi-arid land, and regional climate change.
Dr. Iphigenia Keramitsoglou	National Observatory of Athens (Greece)	Iphigenia Keramitsoglou is a Research Director in Earth Observation at NOA, specialized in Urban Thermal Remote Sensing. Among other projects, she is coordinating the EXTREMA "Emergency notification system for extreme temperatures" for the prestigious international city network of "100 Resilient Cities" (100RC; <a href="http://www.100resilientcities.org/">http://www.100resilientcities.org/</a> ; pioneered by Rockefeller Foundation). She is acting as Temporary Advisor of World Health Organisation, European Working Group on Health in Climate Change. She is collaborator of NASA project URBANLST "A high spatio-temporal resolution Land Surface Temperature (LST) product for urban environments".

Dr. Thomas Esch	German Aerospace Center (Germany)	Thomas Esch is the Head of Team for Urban Areas and Land Management at DLR. He was a Scientific Employee at the Department of Remote Sensing, University of Würzburg where he was working on urban remote sensing applications (2006-2008). In 2008, he was with DLR-DFD and became leader of the team “Urban Areas and Land Management” in 2009. He has extensive experience as he has participated in about 15 research projects in the context of EO, SAR applications, sustainable urban development, land management, biodiversity and renewable energies and energy efficiency.
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The members of the Advisory Board will be invited to annual GUOI symposium. They will be given annual progress reports and be asked to offer independent, impartial advice on implementation progresses and potential areas for improvement. Furthermore, the AB may be contacted any time by the Project Coordinator, should any unforeseen technical or programmatic issues arise that would benefit from their inputs.

#### 6.4. Communication with partners and participants

To ensure the project making progress in a timely manner, we plan to have a monthly tele-conference. Quarterly newsletters will be sent to the co-leads and contributors from the office of Project Coordinator.

Physical meetings of leads and contributors will be scheduled at annual GUOI symposium. During a physical meeting, a draft annual Progress Report will be discussed, so that progress towards the defined targets of the previous year can be assessed, and planning for next year’s activities would be made.

#### 6.5. Description of the roles of key leadership positions

Role	Member or PO	Implementing Entity	Contact Name	Email Address
Lead (PoC), Project Coordinator	United States	<a href="#">Indiana State University</a>	Qihao Weng	qweng@indstate.edu
Co-Lead	Sweden	<a href="#">KTH Sweden</a>	Yifang Ban	yifang@kth.se
Co-Lead	China	Nanjing University	Peijun Du	dupjrs@126.com
Co-Lead	United States	<a href="#">NOAA</a>	Chris Elvidge	chris.elvidge@noaa.gov
Co-Lead	Germany	<a href="#">DLR</a>	Thomas Esch	thomas.esch@dlr.de
Co-Lead	IEEE / Italy	<a href="#">GRSS / Univ. of Pavia</a>	Paolo Gamba	paolo.gamba@unipv.it
Co-Lead	Greece	<a href="#">NOA</a>	Iphigenia Keramitsoglou	ik@noa.gr
Co-Lead	United States	<a href="#">NASA</a>	Dale Quattrochi	dale.quattrochi@nasa.gov
Co-Lead	United States	Universities Space Research Association	Miguel O. Román	mroman@usra.edu
Co-Lead	India	National Institute of Urban Affairs	Umamaheshwar -an Rajasekar	urajasekar@niua.org
Co-Lead	United States	<a href="#">USGS</a>	George Xian	<a href="mailto:xian@usgs.gov">xian@usgs.gov</a>

Contributor	Austria	<a href="#">University of Salzburg</a>	Thomas Blaschke	thomas.blaschke@sbg.ac.at
Contributor	Brazil	University of São Paulo	José Alberto Quintanilha	josealberto.quintanilha@gmail.com
Contributor	Canada	University of Calgary	Geoffrey Hay	gjhay@ucalgary.ca
Contributor	Canada	University of Toronto	Yuhong He	yuhong.he@utoronto.ca
Contributor	China	<a href="#">CMA</a>	Guangzhen Cao	caogz@cma.gov.cn
Contributor	China	<a href="#">CMA</a>	Jinlong Fan	fanjl@cma.gov.cn
Contributor	China	Chinese University of Hong Kong	Hongsheng Zhang	stevenzhang@link.cuhk.edu.hk
Contributor	China	Hong Kong Polytechnic University	Xiaoli Ding	lsxlding@polyu.edu.hk
Contributor	China	Chinese Academy of Sciences	Linlin Lu	lull@radi.ac.cn
Contributor	China	Chinese Academy of Sciences	Qingling Zhang	ql.zhang@siat.ac.cn
Contributor	Germany	<a href="#">DLR</a>	Hannes Taubenböck	hannes.taubenboeck@dlr.de
Contributor	Germany	University of Hamburg	Benjamin Bechtel	benjamin.bechtel@uni-hamburg.de
Contributor	Italy	<a href="#">EUCENTRE</a>	Fabio Dell'acqua	fabio.dellacqua@unipv.it
Contributor	Japan	University of Tokyo	Hiroyuki Miyazaki	heromiya@csis.u-tokyo.ac.jp
Contributor	Japan	<a href="#">AIST</a>	Koki Iwao	iwao.koki@aist.go.jp
Contributor	Japan	University of Tokyo	Masahiko Nagai	nagaim@iis.u-tokyo.ac.jp
Contributor	Japan	University of Tokyo	Ryosuke Shibasaki	shiba@csis.u-tokyo.ac.jp
Contributor	Pakistan	<a href="#">University of Karachi</a>	Salman Qureshi	salmanqureshi@uok.edu.pk
Contributor	South Africa	<a href="#">SANSa</a>	Naledzani Mudau	nmudau@sansa.org.za
Contributor	Spain	<a href="#">CIEMAT</a>	Begoña Artiñano	b.artinano@ciemat.es
Contributor	Spain	<a href="#">CIEMAT</a>	Fernando Martin	fernando.martin@ciemat.es
Contributor	Spain	<a href="#">IGN</a>	Antonio Arozarena	aarozarena@fomento.es
Contributor	United States	<a href="#">LDEO</a>	Chris Small	small@LDEO.columbia.edu
Contributor	United States	Yale University	Karen Seto	karen.seto@yale.edu
Contributor	United States	<a href="#">NASA</a>	Marc Imhoff	marc.l.imhoff@nasa.gov
Contributor	United States	USDA	Feng Gao	feng.gao-1@nasa.gov
Contributor	United States	Iowa State University	Yuyu Zhou	yuyuzhou@iastate.edu

## 6.6. Strategy for communication with participants and stakeholders

To ensure the project making progress in a timely manner, we plan to have a quarterly tele-conference. Quarterly newsletters will be sent to the leads and contributors from the office of

Project Coordinator.

Physical meetings of leads and contributors will be scheduled at annual GUOI symposium. During a physical meeting, a draft annual Progress Report will be discussed, so that progress towards the defined targets of the previous year can be assessed, and planning for next year's activities would be made.

We plan to send at least one representative to annual GEO Work Programme Symposium and if feasible to each GEO Plenary. Regular (e.g., Quarterly) reports will be sent to the participating organizations, GEO Programme Board (PB) and GEO Secretariat.

The participants in China plan to have a physical meeting every year to review and advance the regional applications of GUOI projects, and the international participants will be invited for coordination and direction.

### 6.7. Risk management

Early identification of possible risks and the associated risk control procedures is important for the seamless execution of a collaborative project. Risk assessment will take place at any time of the project and will aim at the timely identification of potential risks. Risk control will contribute to monitor the identified risks and take all necessary actions to reduce their effects. The basis of risk management is a set of actions foreseen to reduce certain general risks. GUOI 2020 can be viewed as a 3-yr international collaborative project with numerous partners from different countries. The general risks for such a project can be classified in different categories. For each category, we explain what we have foreseen in GUOI 2020 to address the relevant problems that might arise. The Project Coordinator is to decide whether the problems will be tackled by the task leads, the Project Technical Committee, or the Advisory Board on a case-by-case basis.

**Scope Risks.** GUOI 2020 has clearly defined its start and finish point. The scope and concept is analyzed in a series of activities and tasks minimizing uncertainty in the scope of the project.

**Schedule Risks.** GUOI 2020 has allowed realistic times for each task and represented in the Gantt chart. The project coordinator along with the co-leads will be monitoring the progress through tight timelines, deliverables (including reporting) and milestones. Frequent Advisory Board meetings will proactively monitor effort expended on the various tasks, adjust and re-plan as necessary. In case of difficulty in fixing dates for Advisory Board meetings, advanced planning is foreseen to avoid conflicting events. Teleconferencing will be offered as an option to physical presence. Project dependencies are designed so as to minimize schedule risk; working in parallel tasks (Gantt and Pert charts) will help towards this end.

**Budget Risks.** Each participating organization has its own budget. A travel plan has been drafted as early as the proposal writing up to identify realistic costs tied with the needs of the project.

**Scientific and Technical Risks.** A thorough review of the current state-of-the-art in GEO GI-17 was done in February 2019 by the GEO Secretariat and the Project Coordinator which also define the steps forward. GUOI 2020 will have embedded self-assessment performance routines (such as polling) which will generate alerts in of certain failures (e.g. a task is inactive for more than 3 months). In addition, GUOI 2020 has the support of world leading scientists in the field of urban remote sensing as members of the Advisory Board. Their impartial advice and dedication on their own tasks are keys to the success of the project.

Last but not least, should a partner faces unforeseen difficulties that will have a major impact on the

implementation of the project, there will be a crisis management meeting and measures will be decided in coordination with EC project officer.

## 7. Resources

### Projects:

- The U.S. NLCD production is supported by the USGS and other nine federal agencies under the Multi-Resolution Land Characteristics (MRLC) consortium with annual budget of over 6 million US dollars.
- German Remote Sensing Data Center (DFD) and German Aerospace Center (DLR) have annual budget to support Global Urban Footprint production.
- “Thematic Urban Observation Hub (TUrbO-Hub) - Platform for the Mapping, Analysis, Monitoring and Assessment of Urban Development” supported by ESA Invitation To Tender/1-7870/14/I-NB Thematic Exploitation Platforms (TEP) program, led by DLR.
- “Earth Observation for Urbanization” (EO4U)” supported by the ESA Invitation To Tender (ITT) AO/1-7829/14/I-NB DUE – Innovators III program, led by DLR.
- EO4Urban, funded by ESA, annual budget €100 000, led by Yifang Ban, KTH.
- Sentinel4Urban, funded by the Swedish National Space Board, €108 000 (1Mkr)/year during 2016-2019.
- Dragon 4 ‘Earth Observation Based Urban Services for Smart Cities and Sustainable Urbanization’, Yifang Ban, Paolo Gamba, 2016-2020, funding for three PhD students and travel grants.
- “Inter- and intra-annual dynamics of urban impervious surfaces in the Pearl River Delta using deep learning networks from synergized optical and SAR data”, 2018-2020. HK\$ 845,000, PI: Hongsheng Zhang.
- EXTREMA “EXTREme tEMperature Alerts for Europe”, DG-ECHO Prevention (2018-19)
- NASA Goddard Space Flight Center/Marshall Space Flight Center Interdisciplinary Science Project, “Combining satellite data and models to assess the impacts of urbanization on the continental United States surface climate”.
- NOAA’s National Geophysical Data Center has a long-standing program to generate and provide open access to global nighttime lights from satellite data. They are now working on VIIRS DNB products.
- Global Talents Program of Fujian Province, China, in support of creation of Global Institute of Sustainable Cities.
- Indiana State University has a few graduate student research projects focusing on global urban observation methods and techniques supported respectively by USGS IndianaView Consortium.
- ASTER Global Urban Area Map (AGURAM) developed by National Institute of Advanced Industrial Science and Technology of Japan and University of Tokyo.
- CAS Earth Big Data Science Project is a strategic priority research program (class A) of the Chinese Academy of Sciences. It was officially approved in January 2018. CASEarth aims to draw advantages from extensive resources of CAS and other units in China to develop a data-sharing platform to host big data and cloud services to cater for the modern data intensive scientific applications for a wide variety of fields including resource management, environment sciences, biology and ecology and many others. The Digital Belt and Road program (DBAR) which is funded by CASEarth project is an international science program for the sustainable development of the Belt and Road region using big Earth data. The Urban Environment Task Force of DBAR is co-chaired by Linlin Lu, Chinese Academy of Sciences.
- The World Urban Database Access Portal Tool (WUDAPT, <http://www.wudapt.org/>) is currently gathering climate relevant data on the form and functions of cities worldwide using remote sensing and crowd sourcing. WUDAPT has developed to this point as a

co-operative venture among interested parties that have committed their time and resources. It has received support from institutions to host meetings and laboratories to develop data gathering protocols and has generated several student research projects that are supported by university funding.

- Map trees infested by the emerald ash borer using high spatial resolution remote sensing data, 2014-2020. This is a project initially funded by UTM office of VP Research in 2013 and then received a 5-year Early Researcher Award from the provincial Ministry of Research and Innovation in 2015 to map EAB infestation in Ontario using field data, satellite images and UAV images. This work is collaborated with Credit Valley Conservation and Invasive Species Center. PI: Yuhong He, University of Toronto, Canada.
- Urban impervious surface data generation for selected Chinese cities, supported by National Natural Science Foundation of China (Grant No. 71503099), RMB ¥ 212,400, and City environmental monitoring program of Guangzhou Science Technology and Innovation Commission, RMB ¥ 1,000,000.
- Characterizing global urban areas and mapping global urbanization dynamics at 30 m resolution and an annual interval, through combining nighttime light imagery and Landsat and Sentinel-2 imagery on a cloud computing platform, support by Chinese Academy of Sciences through the “100 Talent Program”, 2016-present.
- Intelligent interpretation of time series remote sensing image for spatio-temporal analysis of geographic process, supported by National Natural Science Foundation of China (Grant No. 41631176), RMB ¥ 2,960,000, from 2017/01/01-2021/12/31

#### **In-kind (human resources)**

- Center for Urban and Environmental Change, Indiana State University, U.S.A.;
- Data, models, and related resources associated with US NASA Earth Science research and Earth observing remote sensing platforms such as Terra and Aqua, and the 40-year availability of continuous Landsat data;
- Additional in-kind contributions from IEEE Geoscience and Remote Sensing Society, USA (NASA) and China (Nanjing University, Xiamen University, Hong Kong Polytechnic University, National Satellite Meteorological Center), Italy (University of Pavia), and International Society of Photogrammetry and Remote Sensing.

## **8. Technical Synopsis**

### **8.1. Essential datasets used and created by GUOI 2020**

#### ***Raw data:***

- VHR SAR (TerraSAR-X);
- Landsat data;
- Sentinel data;
- MODIS data;
- VHR Optical data (e.g., IKONOS, QuickBird, WorldView imagery);
- VIIRS/ Suomi NPP
- Chinese GF series and ZY series data

#### ***Thematic layers:***

- Urban extent;
- Urban extent change maps;



- Essential environmental variables (land surface temperature, emissivity, albedo, vegetation cover, impervious surface, water body);
- Urban morphology (built-up structures, average distance between built-up structures, classification);
- Indicators of sustainable cities (impervious surface, land use and land cover types, built-up density, land surface temperature, vegetation fraction etc.)
- Socio-economic information derived from Nighttime Light image (DMSP/OLS, NPP VIIRS)
- SDG11 indicators derived with earth observation data in selected pilot regions and cities

**Potential data users:**

- Local/regional/country scales
  - Involved institutions (meaning users) in the cities (urban and spatial planning).
  - Local/regional/national environment and planning agencies.
  - EU directorate general regional policy (DG REGIO)
  - Energy suppliers
  - City authorities and Resilient Offices
- Global scale
  - UN-Habitat
  - World Bank
  - Science community (e.g. Urban Climate Modelers, Epidemiologists)
  - Education

**Potential data providers:**

- The US (NOAA National Geophysical Data Center) has produced global radiance calibrated VIIRS low light imaging products: 1) nightly, 2) monthly, and 3) annually. NGDC is still developing algorithms for producing research quality nighttime lights, with background noise, fires, and aurora removed. The World Bank (Sustainable Development Unit) is using the radiance VIIRS products to rate the success and longevity of electrification projects in India, Vietnam and Indonesia;
- The Global Urban Footprint (GUF), the Global Urban Area Map (AGURAM), and the Global Urban Extent, generated by Germany Space Agency (DLR), include user groups of the World Bank Group, the European Environment Agency (EEA), DG Regio of the European Commission, the International Society of City and Regional Planners (ISOCARP) etc. Moreover, DLR has produced a time-series analysis (1975-2010) describing the spatiotemporal development of 26 mega-cities, also setting up a global data base of binary settlements masks (Global Urban Footprint) derived from SAR data of the TanDEM-X mission (grid cell size: ~50x50 m);
- Sweden (KTH) and Italy (University of Pavia) have developed an “Urban Extractor” to map global urban extent at 30m resolution using ENVISAT or Sentinel-1 SAR data;
- Japan (GEO Grid/AIST, University of Tokyo) has developed the ASTER Global Urban Area Map (AGURAM). 3734 cities of more than 0.1 million people urban area have been mapped using ASTER (15m). Gaps will be filled using PALSAR data.
- U.S. Geological Survey has released the National Land Cover Database (NLCD) 2011 products, including impervious surface changes between 2001-2006, and 2006-2011. The NLCD urban land product has been widely used by many scientific studies including land cover change and climate change impact in the United States and around the world. Many GEO participants are the users of NLCD products. New NLCD 2016 will be released in the spring 2019 and provide over 16-years urban land change information. The USGS LCMAP annual land change product that will be released in the summer 2019 will enriched land cover

change information and can be used to assess land change from 1980s to 2017 in the United States.

- Satellite derived LST products are available online at no cost.
- Commercial data provider: Planet Labs, California, is building and launching a large constellation of Earth Imaging satellites with the goal of daily imaging the entire earth (land), and has contacted Dr. Weng to offer free access of the acquired imagery for demonstrating urban applications.
- China Center for Resources Satellite Data and Application, and Land Satellite Remote Sensing Application Center of Ministry of Natural Resources, can provide the GaoFen (GF) series and Ziyuan (ZY) series data for some specific areas

## 8.2. Key methods used to transform the source data into the products and/or services

### Deliverables:

- Urban footprint/urban extent, urban land cover change, human settlement datasets at global, regional, and national scales generated by several groups;
- Models and algorithms:
  - Spatio-temporal Adaptive Data Fusion Algorithm for Temperature mapping (SADFAT) – Merge coarse resolution and medium resolution satellite image data to generate daily medium resulting data;
  - DELTA algorithm to reconstruct consistent, daily land surface temperature data at Landsat resolution based solely on Landsat imagery;
  - Object-based Urban Thresholding method for NTL image data (NTL-OUT) – Calibrate inconsistent time-series DMSP/OLS NTL image data to map and update large-scale urban areas; and
  - EXTREMA Service of real-time, operational, 5 minute monitoring of land and air surface temperature and humidity for cities;
- Information about existing data gaps in integration of global urban observations with (i) data characterizing urban ecosystems, thermal environment, geohazards, air quality, and carbon emission; (ii) indicators of population density, environmental quality, and quality of life; (iii) social and economic data; and (iv) patterns of human, environmental and infectious diseases;
- A set of "indicators" that quantify the status and trends of cities and human settlements and support the urban sustainable development goal that is being planned for at the UN.
- Systems and tools: (1) Thematic Urban Observation Hub (TUrbO-Hub) - Platform for the Mapping, Analysis, Monitoring and Assessment of Urban Development; (2) SAR4Urban: Provide data sets of selected cities from ESA radar imagery to the users of the cities; and (3) Urban Extractor: to map global urban extent at 30m resolution using ENVISAT or Sentinel-1 SAR data; (4) EO4Urban - Urban extent maps over 10 cities experiencing rapid urbanization; (5) Sentinel4Urban – Urban extents extraction using Sentinel data; (6) Dragon 4 - Earth Observation Based Urban Services for Smart Cities and Sustainable Urbanization;
- Publications: Journal special issue on environmental sustainability in South America, Asia-Pacific region, and Africa, and a new book “*Geospatial Big Data for Sustainable Cities*”;
- Assessment of the developed tools, systems, and models by decision makers and user partners;
- Annual International Summer School;
- Joint filed works in selected cities or regions;
- Annual GEO Global Urban Observation symposium.

### Delivery Schedules:

	2020	2021	2022
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	3	6	9	12	3	6	9	12	3	6	9	12
<b>Objective 1: Datasets on urban areas and human settlements</b>												
NOAA light imaging products												
DLR Global Urban Footprint												
Global urban extent from “Urban Extractor”												
Japan ASTER Global Urban Area Map												
USGS NLCD												
Chinese urban impervious surface maps (200 cities) (Wuhan University, China)												
Global urban extent using nightlight and optical imagery (Chinese Academy of Sciences, Shenzhen)												
Global urban extent dynamics with nightlight imagery (Indiana State University)												
<b>Objective 2: Models, algorithms and Services</b>												
SADFAT												
DELTA												
NTL-OUT												
EXTREMA												
<b>Objective 3: Systems and tools</b>												
TURbo-Hub (DLR)												
SAR4Urban (DLR)												
Urban Extractor (Pavia)												
EO4Urban (KTH Sweden)												
Sentinel4Urban (KTH Sweden)												
Dragon 4 (KTH Sweden, Pavia)												
<b>Objective 4: Knowledge Base</b>												
Information about existing data gaps												
Sustainable cities indicators												
<b>Objective 5: Results distribution</b>												
Remote Sensing Journal special issues												
Book “Geospatial Big Data for Sustainable Cities”												
<b>Objective 6: Capacity building and user engagement</b>												
User assessment of tools and datasets												
International Summer School												
Joint Field Works in Selected Cities/Regions												
Annual GEO GUOI symposium												

8.3. Significant scientific or technical issues that need to be resolved by the Initiative

A major goal of GUOI 2020 is to develop a series of satellite based essential urban variables and

indicators of sustainable cities to support UN SDG Goal 11 through international cooperation and collaboration. To achieve this goal, we plan to a specialized workshop in summer 2020.

**Workshop Theme:** EO Based Essential Urban Variables and Indicators for Sustainable Cities

The goal will be to develop a systematic assessment of essential urban variables and indicators for sustainable cities that can be generated from Earth Observation data. These variables and indicators are tailored to support the UN SDG Goal 11 - Make cities inclusive, safe, resilient and sustainable – and used in World Bank, UN Habitat, and local agencies of planning and environmental management, natural resources, metropolitan transit, sustainability, public health, and regional statistics in the forms of datasets, products, and services. The workshop will also discuss related issues on sensors, data, assessment and validation, and scales.

All GUOI participants are welcomed to join, as well as others with the interest. Potential new contributors, students, and young researchers are especially welcomed to attend. The workshop is free to the participants.

### **Invited Participants:**

There will be a few invited participants to the workshop, who will write a background short paper (i.e., white paper) prior to the workshop to contribute to the project idea. These white papers will serve as our starting points for discussion in the workshop.

Each invited participant will need to write a 3-page (font 12 points, double space) white paper contributing to the development of a systematic assessment of essential urban variables and indicators for sustainable cities that can be generated from Earth Observation data. The white paper can also focus on related issues of sensors, data, assessment and validation, and scales in the development of the urban variables and indicators.

Travel support of the invited participants will be covered by the organizer.

A significant scientific issue needs to be resolved by the initiative is the synergy of multi-scale and multi-source urban extent and land cover maps. To address it, we plan to use two strategies: 1) using decision level fusion to combine the results of different sources under the guidance of experts; 2) promoting collaborative fieldwork and validation to optimize the image processing algorithms for urban areas with different geographic and landscape environments.

## **9. Data Policy**

### [9.1. Data availability policy](#)

Data and information produced from this project will be incorporated into a web interface compatible with common mapping applications. The datasets will be geocoded allowing user queries and downloading. A graphical interface will be developed as a JavaScript API to function as a Google Earth plug-in. Then this application will be embedded into our website, designed and dedicated to facilitating dissemination of the results and engaging users.

### [9.2. Data management](#)

Each co-leading partner will provide details for key datasets used or created, of the extent to which they conform to the GEOSS Data Sharing Principles, whether they will be part of the GEOSS Data CORE and whether they will be managed using as reference the GEOSS Data Management Principles. Where applicable, the co-leading partners will provide details on interoperability with the GCI (GEOSS Common Infrastructure).

### [9.3. Strategy for longer-term preservation of data and information produced by the Initiative](#)

## Data Management and Access

### (1) Types of data and samples to be produced in the project:

A multi-dimensional data set will be produced through this project. Collection of existing maps and other pertinent data will also be arranged. To facilitate data management, geospatial data, field collected data, and all spatial ancillary data will be stored in a common GIS database.

### (2) Standards for data format and metadata content to be used:

This project will adopt the National Spatial Data Infrastructure standards. We intend to develop metadata documenting the data format, origin, methods of collection and production, value added for each geospatial data layer. These data can be used and accessed in most widely used computing environments. All GIS data layers will be created compatible with ArcGIS. All metadata will be provided in plain text format.

### (3) Policies for access:

Data and information produced from the models and algorithms of the project will be incorporated into a decision support interface that is compatible with common mapping applications. To provide information to the public, the data produced in this project will be geocoded allowing user queries of the data by address and downloading. A graphical interface will be developed as a JavaScript API to function as a Google Earth plug-in. This application will then be embedded into the project website, designed and dedicated to facilitating the interpretation of information resulting from the research. Data generated by EXTREMA are provided as a personalized heat health service via EXTREMA mobile app for certain cities.

Data derived from high-resolution aerial photographs will not be released to the general public for potential privacy issue. Data collected from pertinent government agencies will not be released to other parties, unless those data are already in the public domains.

### (4) Policies for re-use, distribution, or the production of derivatives:

The data, information, models, and algorithms to be produced by this research may be re-used (after explicit consent of the data provider) by other researchers, educators, students, or general public. Concurrent use of the same data for a different purpose by a third party will be considered. In some cases licensing and pricing may be required. Publications by a third party using the data or derived products from this project will be required to acknowledge the contribution of this project.

### (5) Plans for archiving data and samples and preservation of access:

All data and other data products will be archived with detailed metadata whenever appropriate. The level of details will be equivalent to the existing data archived in ORNL DAAC. We anticipate the ORNL DAAC will eventually archive the public domain data for wider distribution similar to other national projects.

**Tables** (use downloadable spreadsheet for data entry) **updated annually**

- A. Individual Participants
- B. Confirmed Contributions
- C. Task / Work Package Structure
- D. Deliverables / Milestones

**Annexes** (additional annexes may be added as required)

- III. Brief CV of Project Leader

**Dr. Qihao Weng**, an IEEE Fellow, is the Director of the Center for Urban and Environmental Change and a Professor of Geography at Indiana State University, and had worked as a Senior Fellow at the National Aeronautics and Space Administration from 2008 to 2009. He received his Ph.D. degree in geography from the University of Georgia in 1999. Weng is currently the Lead of the Group on Earth Observation's (GEO) Global Urban Observation and Information Initiative, and serves as an Editor-in-Chief of the ISPRS Journal of Photogrammetry and Remote Sensing. Additionally, he works as the Series Editor of Taylor & Francis Series in Remote Sensing Applications and Taylor & Francis Series in Imaging Science. Weng has been the Organizer and Program Committee Chair of the biennial IEEE/ISPRS/GEO-sponsored International Workshop on Earth Observation and Remote Sensing Applications conference series since 2008, a National Director of the American Society for Photogrammetry and Remote Sensing from 2007 to 2010, and a panelist of U.S. DOE's Cool Roofs Roadmap and Strategy committee in 2010.

In 2008, Weng received a prestigious NASA senior fellowship. He received the Outstanding Contributions Award in Remote Sensing in 2011 from the American Association of Geographers in 2011 as well as the Willard and Ruby S. Miller Award in 2015 for his outstanding contributions to geography. Furthermore, he was given the Taylor & Francis Lifetime Achievements Award in 2019. In 2005, at Indiana State University, he was selected as a Lilly Foundation Faculty Fellow. In the following year, he also received the Theodore Dreiser Distinguished Research Award. Weng was the recipient of 2010 Erdas Award for Best Scientific Paper in Remote Sensing (1st place) and the 1999 Robert E. Altenhofen Memorial Scholarship Award, which were both awarded by the American Society for Photogrammetry and Remote Sensing. He was also awarded the Best Student-Authored Paper Award by the International Geographic Information Foundation in 1998. Weng has been invited to give more than 110 talks by organizations and conferences held in U.S.A., Canada, France, China, Spain, Brazil, Greece, UAE, and Hong Kong, and he is honored with distinguished/chair/honor/guest professorships at twelve top universities in China which include Peking University. In 2018, he was elected as a fellow of the Institute of Electrical and Electronics Engineers and a member of the EU Academy of Sciences.

Weng's research focuses on remote sensing applications to urban environmental and ecological systems, land-use and land-cover changes, urbanization impacts, environmental modeling, and human-environment interactions. Through a serial invention of innovative algorithms, techniques, methods and theories for urban remote sensing, Weng's research fosters the science and technology of remote sensing and satellite imaging in geographical and environmental applications while narrowing the gap between geography, geosciences, and landscape ecology. Weng is the author of 228 articles (journal articles, chapters, and others) and 13 books. According to Google Scholar, as of January 2019, Weng's publications accumulated 15,000 citations (H-index of 56), and 36 of his publications have had more than 100 citations each. Weng's research has been supported by agencies that include NSF, NASA, USGS, USAID, NOAA, National Geographic Society, European Space Agency, Hong Kong Research Council, and the Indiana Department of Natural Resources.