Report of Survey on Digital Earth Vision Towards 2030

International Society for Digital Earth

February 2020

Content

The survey on "Digital Earth Vision towards 2030" is conducted by the International Society for Digital Earth (ISDE) in February 2020, aiming to collect views and thoughts on the current status of Digital Earth and on its development trend towards 2030.

The whole questionnaire consists of 21 questions. It was made using SurveyMonkey and sent out to more than 16 thousand persons who might be interested in via emails. During one month's survey time, 314 surveyees returned their answers. All answers have been downloaded and statistically analyzed below.

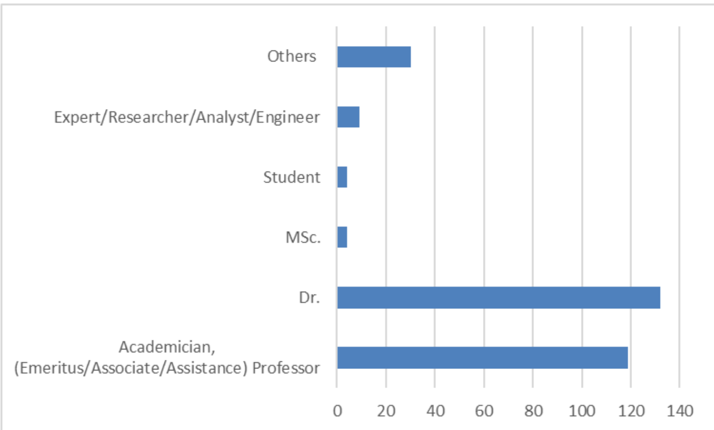
Q1: What is your name?

291 surveyees provide full names. These information are confidential and only will be used for possible contact in the future.

Q2: What is your title?

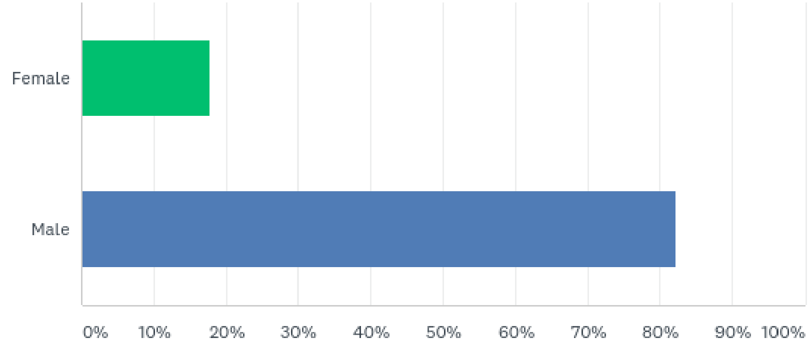
298 surveyees' titles include

- Academician, (Emeritus/Associate/Assistance) Professor (119)
- Dr. (132)
- MSc. (4)
- Student (4)
- Expert/Researcher/Analyst/Engineer (9)
- Others (30)



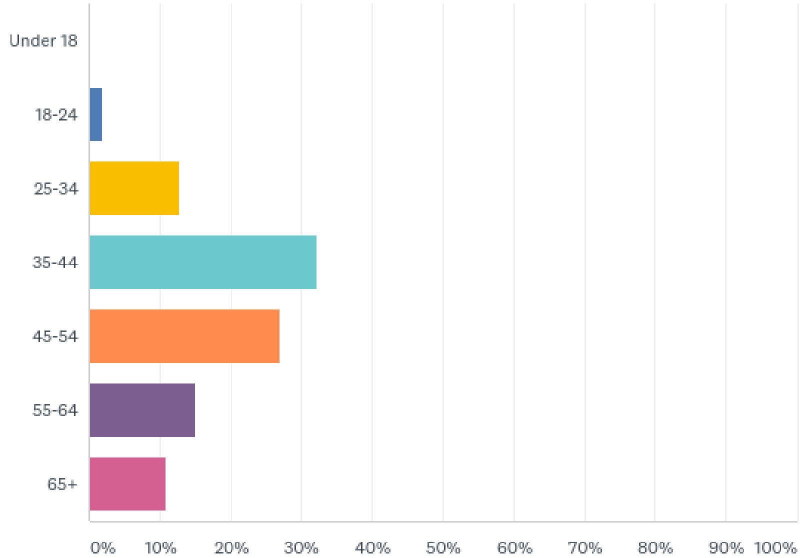
Q3: What is your gender?

ANSWER CHOICES	RESPONSES	
Female	17.80%	55
Male	82.20%	254
TOTAL		309



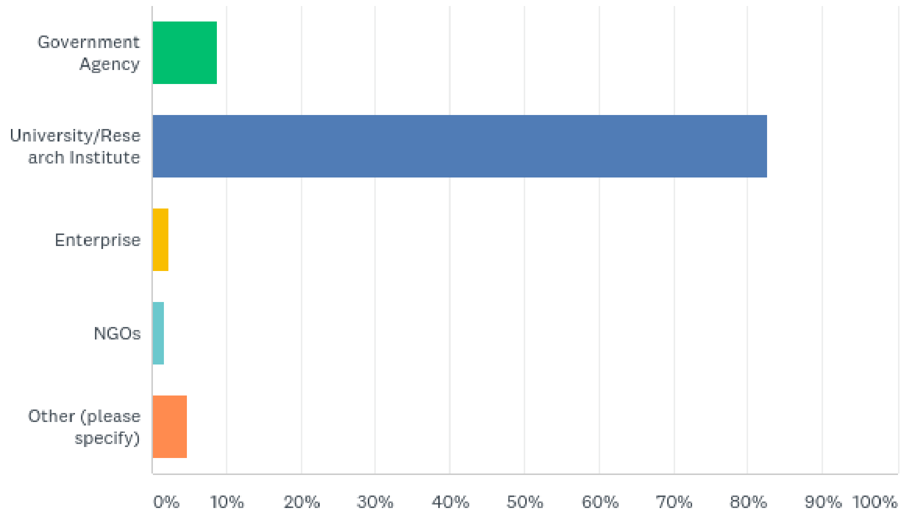
Q4: What is your age?

ANSWER CHOICES	RESPONSES	
Under 18	0.00%	0
18-24	1.93%	6
25-34	12.86%	40
35-44	32.15%	100
45-54	27.01%	84
55-64	15.11%	47
65+	10.93%	34
TOTAL		311



Q5: What is your affiliation type?

ANSWER CHOICES	RESPONSES	
Government Agency	8.71%	27
University/Research Institute	82.58%	256
Enterprise	2.26%	7
NGOs	1.61%	5
Other (please specify)	4.84%	15
TOTAL		310



Others:

- United Nations / UN System
- UNEP
- European Space Agency (ESA) Climate Office
- European Union Agency
- Private company
- Public institution
- Intergovernmental organization
- International organizations
- Publisher
- Alumni Student Eastern Michigan University
- Self-employed/Independent consultant
- Volunteer
- Invited expert by the Scientific Council on Space Research
- MoFAT

Q6: Which country are you from?

303 surveyees from 63 countries of Asia, Europe, America, Australia, and Africa

answered this question. The countries (and surveyee numbers) are as below:

Algeria (1)	Czech Republic (3)	Israel (2)	Romania(2)
Argentine (1)	Denmark (2)	Italy (18)	Russia (5)
Australia (8)	Ecuador (1)	Japan(2)	Serbia (1)
Austria (6)	Egypt (3)	Jordan(1)	South Africa (3)
Bangladesh (3)	Estonia (1)	Kenya(1)	South Korea (2)
Belarus (1)	Ethiopia (1)	Macedonia(1)	Spain (23)
Belgium (3)	Finland (1)	Malaysia(2)	Sudan (1)
Brazil (3)	France (10)	Mexico (3)	Sweden (1)
Bulgaria (3)	Germany (10)	Mongolia (1)	Switzerland (2)
Burkina Faso (2)	Greece (3)	Morocco (1)	Tanzania (2)
Cameroon (1)	Hungary (1)	Nepal (1)	The Netherlands (5)
Canada (8)	India (21)	Nigeria (4)	Turkey (10)
Chile (1)	Indonesia (3)	Norway (2)	UK (10)
China (57)	Iran (3)	Pakistan (5)	Ukraine (1)
Croatia (1)	Iraq (2)	Poland (1)	USA (21)
Cyprus (1)	Ireland (1)	Portugal (9)	

Q7: What is your email address that you would like us to contact you?

275 surveyees provide their email addresses. These information are confidential and only will be used for possible contact in the future.

Q8: What are your current research/working fields related to Digital Earth?

271 surveyees provide their research/ working fields, which cover Digital Earth related technologies and application domains:

• Earth Observation • Remote Sensing • GIScience, WebGIS, 3D GIS • Geophysics • Geovisualization • Geocomputing • Geodesign • Geospatial Modeling • GNSS • Earth Dynamics • Artificial Intelligence, Machine learning, Deep Learning, Agent-	• Climate Change • Sustainable Development • Environmental Health and Sustainability • Environmental and Socio-economic Vulnerability • Ecology, Landscape Ecology, Ecosensitive Region • Biodiversity Conservation • Cryosphere, Snow Properties • Hydrologic Model, Hydroinformatics, River and

Based Modelling-Cellular Automata • Virtual Reality, Augmented Reality, Mixed Reality • Virtual Globes • Virtual Geographical Environment, Virtual Environmental Modeling, • Geomorphic Connectivity • Spatial Information System • Spatial Analysis, Spatio-Temporal Data Model • Visual Analytics • 3D Geovisualization, 3D Mapping, 3D-Modelling • Spatial Data Infrastructure • Cartography • Map Projection • Big data, Big Geospatial Data, Big Earth Data, Data Cubes • Data Fusion • Data Quality • Physical/ Satellite geodesy, Digital Elevation Model • Interoperability • Applied Mathematics • Digital Terrain Analysis • Digital Natural and Cultural Heritage • Spatial Information Grid (Earth Tessellation Grid) • Real-time Situation Awareness • Citizen Science • Navigation • UAV • Digital Twin • Semiotics, Geosemantics, Context Aware System, Semantic Web, Web Sensor, Sensor Data Management • Situational Awareness • Neogeography • VGI • Social Media • Distributed Service	Conservancy, Watershed Analyses • Water Quality, Water Security • Oceanography, Marine Ecosystem Condition, Shoreline Extraction • Arid Area, Desertification • Glaciology, Glacier Mass Balance, Glacier Change Detection • Agriculture, Croplands, Crop Monitoring, Water Resources and Irrigation Monitoring • Landslide Early Detection and Warning • Urbanization, Urban Modeling, Urban Social Dynamics, Urban and Territorial Planning, Smart City, Mega Cities, Urban Slum Mapping and Modelling, Urban Growth Modelling, 3D City Energy Use Model • LULC, Land Cover Classification, Land Degradation, Land Monitoring • Flood Vulnerability Models, Flood Risk Assessment • Forestry, Forest Biomass, Tree Species Classification, Forest Carbon Storage • Disaster Risk Assessment, Disaster Monitoring, Forest Fires, Drought Monitoring • Digital Rock, Digital Mountain • Groundwater • Decision Making, Decision Support System • Atmosphere Science, Boundary Layer Meteorology • Food Security • Digital Health and Quality of Life

Q9: What is your definition of Digital Earth?

193 surveyees provide their definitions of Digital Earth. To give the full views of their understanding of Digital Earth, the raw data is listed below:

- Easy accessibility, not just "availability," of data worldwide
- Digital Earth is the representation of the earth trough digital images and georeferenced data bases.
- The use of digital data and technologies to analyze, model, and represent geographies
- It supports solutions in Digital Age with the use of novel DE technologies based on EO information, scalable spatial data and multi- inter- and transdisciplinary approach to reach actionable insights from local to global and for the benefit of the individuals and the whole society.
- It is a concept of the digitized earth, which includes multi-dimensional attributes of entire earth.
- Digital research on geoscience
- An interconnected, seamless integrated set of digital technological systems to advance human wellbeing and the ecosystem health; comprised of multilevel, multistakeholder initiatives from the public and private sector.
- Like Google Earth, but more than Google Earth
- Map
- Understand the Earth system using systematically measure high-quality data.
- Digital replica of the Planet Earth
- Digital representation of the earth including objects and processes on it.
- Works about geographic information in computer.
- Transforming physical environment into big data
- Science and Technology that Dealing with information in which the location and time matter!
- Big datum
- Digital representation and modelling for earth process understanding
- Representing the earth in a virtual environment with scientific aproaches
- Open data access to satellite data
- It is virtual 3D representation of real world, geographical relations and proces.
- Digital Earth is the name given to a concept by former US vice president Al Gore in 1998, describing a virtual representation of the Earth that is georeferenced and connected to the world's digital knowledge archives.
- The virtual manifestation of our home planet in the digital realm.
- It is a multidisciplinary concept involving representation of the earth using digital technologies (digital data, software/tools and methodologies)
- The digitalization of all the information from the earth
- The platform for disseminating
- Quantitative description of Earth, a universal platform that can integrate all earth related data and serve the community for science research, engineering and other

possible applications.

- Collecting, organizing, storing, visualizing, processing and reporting on big environmental data covering the whole Earth or its major regions
- In the context of climate change science - a virtual equivalent of the Earth on which climate data from Space is 'placed', can be graphically rendered and modelled, and (importantly) integrated together with other climate data and Earth Observation data, such that experiments and simulations with actionable results can be run. A Digital Earth should serve the full variety of user types, including science, education, and policy making, for example.
- A world digitally interconnected and accessible to all citizens
- Computable expression for Earth
- It’s a virtual approximation of dynamic nature of real life earth and it's environment to simulate or predict the natural phenomena.
- Is comprehensive, distributed geographic information and knowledge organization system.
- All entities and elements on Earth are connected and traceable
- Earth information digitalized
- A repository of georeferenced data related to the actual status of the Earth and the object laying on it
- Analysis of geospatial data using digital representations of map data.
- Big Data about the Earth; Management, Analysis and Visualization of the data; Modelling and Prediction of the phenomena of/on/in the Earth
- Description of a geographically hypothetical representation of the world's digital knowledge archives.
- The capability to build a continuously updated integrated information network related to the Earth (urban, sub-urban, Land, Oceans, Ice, ...) starting from remote sensing data and other data source.
- Digital Data and information. Supporting global decision making. Information sharing between public and private organizations. Databases with free and full access.
- High resolution (< 50 cm) multi-spectral, 2 to 5 day receptivity with large swath, atmospherically and Geometrically corrected digital reflectance data with MODIS kind of various products
- Beyond Google Earth
- Everything related to the Earth that is analyzed in numbers.
- Digitalization, network, automation and intelligence of earth resources and environment.
- Digital Earth is very useful to adapt to the development of the information age.
- New environment for surface Earth´s representation
- A blending of the physical environment with virtual worlds that can provide methods and tools for the collective creation of our future - by providing, for example, real time decision support, scenario modelling and impact assessments, and new ways of interactions between (one or more) people and (one or more) machines.

- My definition is taken from the work of David Jensen (UNEP): "Digital Earth is a planetary dashboard to monitor our critical natural resources and ecosystem services at the global, national and local levels". See more at https://medium.com/@davidedjensen_99356/building-a-digital-ecosystem-for-the-planet-557c41225dc2
- Digital spatial data of Earth
- All things can be connected in three dimensions
- A digital representation of all observed geophysical/biophysical features
- A digitized representation of the earth as we know it.
- Digital function: f (real world) = digital world
- Big Geo-Data, georeferenced Information and analyzing
- Five dimensional digital representation of the Earth (surface and subsurface) and atmosphere (the five dimensions denote x, y, z, time, and format of representation i.e. vector and raster)
- I see it as a virtual reality system that contains all the information we have on earth which we can query and selectively visualize and analyze anything that is to do with the Earth, and nearby surroundings of it too (the Moon, solar system, whatever we know about the space). I once talked about "a representation of everything" (http://coltekin.net/arzu/publications/coltekin-clarke-2011-geospatialtoday-editorial.pdf), I suppose this may be the general direction I see it. I also see Internet of Things and Digital Twins stuff that's coming to be an integral part of actually making DE vision a reality eventually.
- Providing solutions to Earth's problems through integration of remotely sensed data.
- Improving knowledge and management of land resources using remote sensing and GIS
- All digital data related to earth surface features and processes
- A comprehensive data set of various types of information, easily accessible, and easy to analyze.
- Digital Earth defines the earth-surface and surface phenomena change into meaningful information and map visualization.
- Representation of earth in digital format
- Modeling the earth system
- Data service for our whole earth
- Digital earth is the collection, storing and gathering of information relating to the earth using GIS or remote sensing device
- Sharing platform
- Linking information technology for better management and protection of resources.
- A digital copy of earth.
- Definition of a virtual version of the Earth georeferenced and linked to the repositories of digital information worldwide.
- Digital representation of the planet.
- Digital Earth is the integration of services, tools and data

- It is a concept describing of virtual representation of the Earth system.
- Global data to take responsibility and action!
- Digitally visualizing the planet earth.
- Modelling the earth in digital environment, as well as the mechanisms, phenomenon of objects/elements on the earth
- Very ambiguous term
- Earth described by digital data
- A flexible integrated information framework that captures and disseminates all recorded data, information and knowledge regarding Earth's phenomena and processes. Earth's digital twin.
- Digital Earth should become an Earth digital twin
- Digital Earth is a way for remote sensing interpreters to exhibit our earth to ordinary people, letting them know what the earth looks like and has undergone.
- Earth's digital twin (of all its elements and systems, natural or artificial or mental)
- A full-scale system of Earth observation, spatial data analysis and societal implementation
- Digital earth is the convergence of digital technologies (sensing, actuating, GIS, GPS, big data, grid computing etc.) with earth sciences, living, and society to enhance the efficiency of delivery of services relying on earth and make these services more precise and personalized to the human and earth's needs.
- A virtual replication of our Earth where all potential (human and natural) scenarios can be simulated
- Continuous Earth monitoring
- Digital representation and application of the earth from past to future
- Digital Earth refers to study the Earth and its interactions with human-beings with digital technologies
- It is an information system to support the research for the future of problems in regard to the Earth.
- Numerical models of earth system
- A cloud-based digital infrastructure that allows users to retrieve, process and share geoinformation products and services that support mapping, monitoring and modelling functions related to socio-ecological processes at various scales.
- Integration of Earth Observation and Information sciences
- Viewing a 3D image of the Earth and being able to benchmark areas of interest
- Cartography
- The key of the Digital Earth is analysis, operation and decision of the geographic elements on the 3D visual Earth.
- Advanced technologies including: earth observation, geo-information systems, global positioning systems, communication networks, sensor webs, electromagnetic identifiers, virtual reality, grid computation
- Our Earth in Digital
- Geographic information in vector or raster format
- It is the concept of Twin Earth, where the Remote Sensing, the IoT and the Big Data from Earth Observation meet.

- All kind of geographical data (raster, vectorial, 3D elements), in static or dynamic format, real-time or historic data, displaying on a 2D or 3D map
- Big data sets from different sources - satellites, ground based remote sensing, in situ data - answering global challenges
- Optical depth of dust aerosol
- Facility
- The Digital Earth is the databases of information collected by satellite and in-situ sensors, the digital models constructed with than data and the forecast models outputs
- Remote Sensing technology in benefit for human being
- Any dataset that could bring the opportunity to analyze changes on Earth
- Transparently, accurately and timely information generation and dissemination
- Digital Earth is an integral part of other advanced technologies including: earth observation, geo-information systems, global positioning systems, communication networks, sensor webs, electromagnetic identifiers, virtual reality, grid computation, etc. It is seen as a global strategic contributor to scientific and technological developments and will be a catalyst in finding solutions to international scientific and societal issues
- An earth with overlapped georeferenced land/sea information a different spatial and temporal resolution
- Digital Twin of the Earth
- A virtual representation of the Earth, multi-scale, multi-sensor, multi-temporal,
- Gathering data about natural phenomenon to build a numeric representation of those natural phenomenon. The numeric representation will help human taking appropriate decision.
- The science that explores, manage and analyses digital data for earth science applications
- Big Earth Data
- All digital data used to survey, analysis and predict phenomena on th earth related to the human activities and environmental consequences
- Digital images + real data
- Deal with the the earth surface objects by way of digital way
- Geo-referenced Earth suitable for spatial analyses, useful for location specific decision making towards prudent management of natural resources
- 'Big Data' allowing for monitoring the Earth Systems (cpomplexes of ecosystems, landscapes, geosystems etc.) at different spatial scales
- Highly Abstraction of Real Earth, overlayed with Information from human needs
- Using big data to quantitatively describe the earth
- Move the earth into a computer
- A body involved in geospatial issues
- The Analysis of Large Data Sets, usually captured from Satellite Platforms and Applied to Regional and Global Scale areas.
- A set of data mapping the Earth and related information manipulation tools.
- The use of information processing to address environmental problems of common

interest

- Digital twin of real word
- Virtual representation of the Earth that is georeferenced and connected to digitized data, information and knowledge archives.
- A collection of detailed geo-data of land , water and air together with processing software, including GIS
- A visual representation of the Earth, georeferenced and connected by web
- To me, 'Digital Earth' represents the combined, readily accessible geo-referenced digital data sets covering all aspects of observing and managing the earth and its environment, including land, sea and meteorology data, and the tools needed to access and use these datasets across multiple themes.
- Digital understanding of 4D Earth systems
- The use of remote sensing, GIS and cartography to visually represent the entire Earth.
- A comprehensive, massively distributed geographic information and knowledge organization system storing, processing, analyzing the information about earth in a digital format.
- Very good infrastructure for geo-spatial technology
- Al Gore's one.
- This is a virtual/digital representation of the Earth and its various systems (geosphere, biosphere, atmosphere,...) that can help understanding the different interactions of those systems through space and time.
- Use of state of art space based, airborne sensors using IoT for earth solutions
- From data to service, not only the infrastructure.
- Infrastructure to collect multisource information and data to study, monitor, analyze, predict events and phenomena occurring on Earth
- All information of the earth has been recorded, processed and analyzed by digital with computer.
- Having easy access to digital data that describe the state of Earth and its processes.
- The use of digital technologies to capture, analyze and share understanding of our planet, its ecosystems and its relationship to the future of humanity. To use and communicate this knowledge to help develop a sustainable future for our planet and its inhabitants.
- Earth in cloud and GIS environment
- It is representation of our earth in such a way that we can extract, analyze and make quick decisions about various phenomena at various scales
- Describing a virtual representation of the Earth that is georeferenced and connected to the world's digital knowledge archives
- Achieving, processing, and management of information on the Earth, including surface, underground and air spheres.
- A digital representation that describes essential parts of the Earth. A Digital Earth exist in different level of details, where we could state that low level of details already exist.
- Spatiotemporal big data analysis

- Earth in digits
- A smart open 3D digital model of the Earth to be used for all kind of purposes by all type of users.
- A vision to monitor and visualize our planet's environmental behaviors and complex interactions [by exploiting the powers of satellites and electromagnetic scanners and sensors to provide what astronauts have described as 'the overview effect'
- Describe earth in digitalization
- Digitized temporal and spatial systems
- Mathematical modeling of earth system processes portrayed geospatially to enhance understanding of earth system dynamics by scientists, decision makers, and the general public
- 3D GIS
- Know and monitoring all earth
- Digitalization of our environment for better life
- Modelling the form and function of physical and human processes on earth in a single, immersive, format.
- Maybe the description, display, mapping of a digital earth in every field regarding land, water, ecology and all biophysical and human fields."
- A vision, concept and framework providing a digital representation of many aspects of Earth for better understanding and management to sustain humankind's livelihoods.
- Digital data, Earth observation.
- Analysis and modeling of Earth Surface data
- The science, technology and application of multiresolution observations, particularly remote sensing imagery, maps and other data for analysis and applications of the Earth over time and space..
- Using digital approaches to understand the Earth
- Virtual georeferenced representation of true Earth
- Transforming and saving all earth data into digital form
- It is a virtual/digital representation of the Earth with some interfaces (sensors / visualization). Within the digital representation analyses can be conducted that tells us something about the physical Earth
- Acquiring and monitoring geodata, following by creating a model (spatial or/and temporal) for forecasting or describing a phenomenon.
- It is a virtual representation of georeferenced Earth where people can access vast amounts of scientific and cultural information to help them understand the Earth and its human activities.
- (2008) Neogeography is a new generation of geospatial products which differs from the previous one (maps and GIS) by three features:
    - using of geocentric coordinates, not mapping projections;
    - using raster, not vector for representation of geospatial context;
    - using hypermedia as transport for semantics.

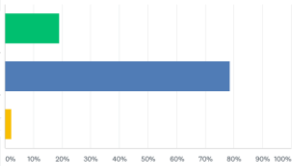
  (2017) Digital Earth is a specific type of geospatial systems that provides scale-independent and projection-independent model of geocentric environment by the means of using sign-less media for the representation of geospatial context.

- Virtual representation of the Earth
- Easy primary observation of earth surface and construct research methods
- It covers the set of digital approaches and technics from various fields that help to better understand and take decision from a wide range of data that can be captured and monitored on our planet and beyond.
- Application of IT technology for Crop fields
- Survey the Earth Using Soft computation.
- Representation of Earth surface with digital data and processing of these data for smart solutions
- Digital replica of Earth
- All earth information is digitated into the computer.
- Use of GPS, GIS and RS technologies to map and monitor Earth resources and processes
- Digital system of the Earth providing technology, data, information, and visualization for society, governments and decision makers.
- Digital Earth is a digitally based system of systems that enables the study and research of Earth's ecosystems, places and the relationships between people and their environments. Digital Earth users examine how human culture interacts with the natural environment, and the way ecosystems, locations and places can have an impact on people. In its final step, Digital Earth, through the art and science of computer-graphics and associated computer models, shall be able to illustrate emerging trends from the present, the past or even modelling eventual scientifically based future predictions.
- Seamless data available for everybody for research and business
- Network of Earth information in various themes and disciplines, which are formatted digitally and could be handled and analyzed by computer systems
- Big data resources and system processing
- The world viewed and studies by digital data captured in pixels of various spectral, spatial, radiometric, and temporal resolutions over time and space in regular time-intervals
- Digital copies of the earth systems
- It an association of technology, data, people, policy, and framework to help advance Earth studies to improve life on Earth.
- Ideally, it is a vast storehouse of spatial data that can be analyzed and visualized in a wide variety of ways. Users should be able to add their own data to the system. Furthermore, users should be able to collaborate with one another when using Digital Earth. Given the vast array of spatial data, and broad range of methods for analyzing and visualizing data, it is probably unrealistic to expect to have all of this in one system.
- Harnessing the prowess of integrated digital age technologies to upgrade the global Intelligent Quotient and improve all communities in decision making for sustainable development.

- I now think of Digital Earth concept as something akin to a digital twin for the whole planet and a platform that we can use for experimentation, measurement, and modeling, etc.
- A virtual Earth with real and product data.

Q10: In 1998 Al Gore proposed a vision for Digital Earth. Do you think today the Digital Earth vision of Al Gore has already been implemented?

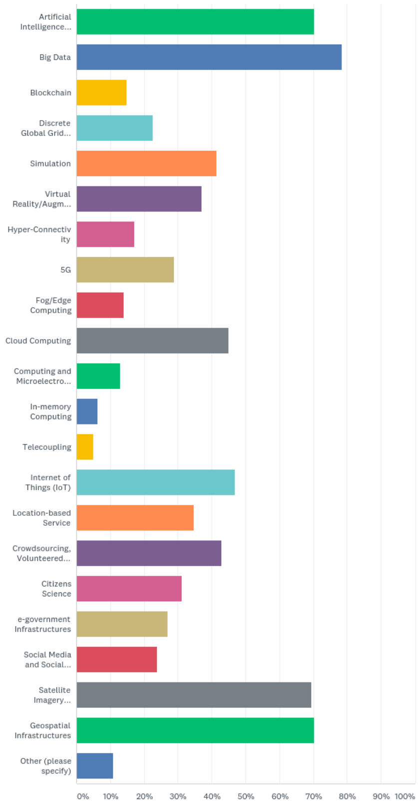
ANSWER CHOICES	RESPONSES	
Yes, this vision has already been implemented	19.05%	40
No, only part of this vision has been implemented	78.57%	165
No, none of this vision has been implemented	2.38%	5
TOTAL		210



Q11: Among the key technologies listed below, which one(s) do you think will mostly contribute to the future of Digital Earth?

222 surveyees choose or give their answers on the key technologies that they believe will mostly contribute to Digital Earth in the future.

ANSWER CHOICES	RESPONSES	
Artificial Intelligence (Machine Learning)	70.27%	156
Big Data	78.38%	174
Blockchain	14.86%	33
Discrete Global Grid Systems	22.52%	50
Simulation	41.44%	92
Virtual Reality/Augmented Reality/Mixed Reality	36.94%	82
Hyper-Connectivity	17.12%	38
5G	28.83%	64
Fog/Edge Computing	13.96%	31
Cloud Computing	45.05%	100
Computing and Microelectronics	13.06%	29
In-memory Computing	6.31%	14
Telecoupling	4.95%	11
Internet of Things (IoT)	46.85%	104
Location-based Service	34.68%	77
Crowdsourcing, Volunteered Geographic Information	42.79%	95
Citizens Science	31.08%	69
e-government Infrastructures	27.03%	60
Social Media and Social Awareness	23.87%	53
Satellite Imagery Processing	69.37%	154
Geospatial Infrastructures	70.27%	156
Other (please specify)	10.81%	24
Total Respondents: 222		



Others:

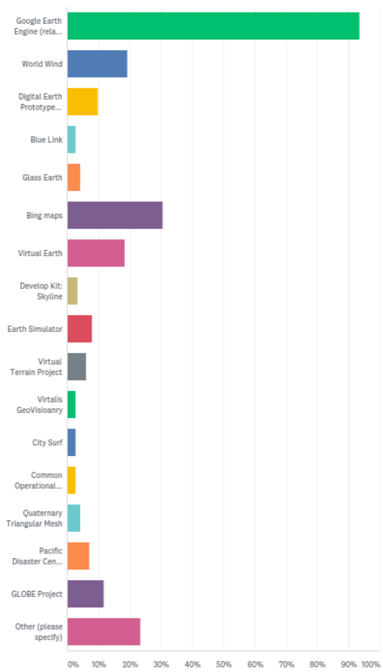
- Earth observation, geo-information systems, global positioning systems, communication networks, sensor webs, electromagnetic identifiers, grid computation
- Image processing and feature extraction (information from imagery from satellite to medical imagery)
- The algorithmic means to mash together many _different_ forms of data.
- Urbanization and population migration
- Automation of machinery, bio-engineering
- Digital Twins
- Data sharing between different teams
- Open data, linked data
- Modeling
- Comprehensive long-term ground based observations like Global SMEAR
- Semantic web technologies si part of artificial intelligence. We need to share some vocabulary and schema in order to improve the integration of several information sources into a common representation.
- Prudent management of ecological region to mitigate global warming
- Quantum computation
- 3D geo-information in the form of point clouds
- Information Fusion
- Consumer technologies such as drones, smartphones and 360 degree cameras
- Standards and SDIs
- Spatial data models
- Virtual and augmented mapping, digital cartography
- Security, privacy and ethics
- Remote sensing science of the Planet Earth
- Almost all of the above items are essential for the vision to be realized and many either overlap other categories listed or are essential precursors for some factors to work. Eg computing and microelectronics and cloud computing and the internet of things are all essential before you can implement machine learning at a global scale.
- No specific technology in Digital Earth, and all technologies listed above are relevant to DE. DE is a new scientific principle, clearly separated from mapping principle.

Q12 What relevant science systems or platforms listed below do you regularly access to or are familiar with? If not in the list, please name them and provide their weblinks.

213 surveyees choose or provide the systems or platforms (with some links) that

they regularly use or are familiar with.

ANSWER CHOICES	RESPONSES	
Google Earth Engine (related Google Moon, Google Mars, Google Map, Google Toolkit)	93.43%	199
World Wind	19.25%	41
Digital Earth Prototype System (DEPS/CAS)	9.86%	21
Blue Link	2.82%	6
Glass Earth	4.23%	9
Bing maps	30.52%	65
Virtual Earth	18.31%	39
Develop Kit: Skyline	3.29%	7
Earth Simulator	7.98%	17
Virtual Terrain Project	6.10%	13
Virtalis GeoVisioanry	2.82%	6
City Surf	2.82%	6
Common Operational Picture	2.82%	6
Quaternary Triangular Mesh	4.23%	9
Pacific Disaster Center Global Hazard Atlas/ Global Hazard Information Network	7.04%	15
GLOBE Project	11.74%	25
Other (please specify)	23.47%	50
Total Respondents: 213		



Others:

- Microsoft Azure
- SAS.Planet
- EarthExplorer
- Alaskan Satelllite Ficilities
- Copernicus Climate Data Store
- Copernicus Open Access Hub
- AppEEARS
- MapX
- World Environmental Situation Room
- Swiss Data Cube
- FEWS Early Warning System
- Here We Go
- Open Street Map
- ArcGIS Online
- Cesium
- ESA Research and User Support (RUS)
- ArcGIS world imagery
- Spatial Data Infrastructures
- Amazon "Earth on AWS"
- Spanish PNOA
- Earthmap (beta)
- NHC
- GEO
- European Space Agency
- NASA products
- LandsatViewer
- OneGeology
- Open Data Cube
- VTK
- PCL
- OpenCV
- Google Tourbuilder (not strictly science but relevant to Digital Earth)
- NSDIs
- INSPIRE
- ESA Hub
- Esri Living Atlas
- Landsat
- Sentinel
- MODIS
- Digital Globe
- GIS Sputnik
- QGIS
- CesiumJS-based solutions like GIS

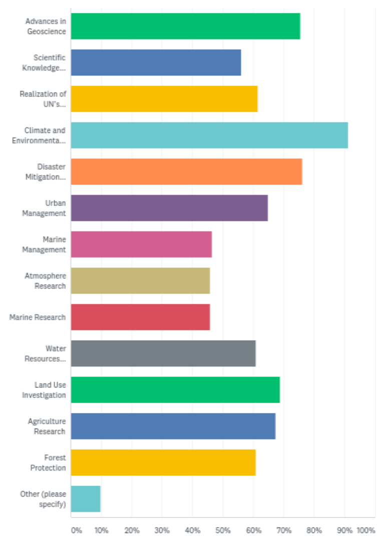
- Earth: null school
- Yandex maps, SNAP
- Copernicus, LandViewer
- ArcGIS Esri
- PEEX
- Global SMEAR
- Sentinel 2 EU program applications
- osgEarth
- Online maps

Sputnik. Previously - Google Earth API

- The COPERNICUS services
- NASA and USGS satellite imagery services
- ArcGIS in all of its various guises,
- Whitebox GAT
- TerrSet
- Erdas
- Web-GIS Climate www.climate.scert.ru
- Moon - World Wind Wiki https://www.worldwindcentral.com/wiki/Moon
- Mars - World Wind Wiki https://www.worldwindcentral.com/wiki/Mars
- Venus - World Wind Wiki https://www.worldwindcentral.com/wiki/Venus
- Mostly ESA activities, such as the ESA Climate Toolbox (http://climatetoolbox.io/).
- https://docs.google.com/spreadsheets/d/1b0N1xW_q8eGUjJVE6RgE3NJb_V-8WHd_ERQE-mQuBGo/edit?usp=sharing
- Geoname French Geoportail https://www.geoportail.gouv.fr/
- https://www.nasa.gov/

Q13: In which field(s) listed below do you think Digital Earth will provide powerful support in the future?

ANSWER CHOICES	RESPONSES	
Advances in Geoscience	75.61%	155
Scientific Knowledge Building	56.10%	115
Realization of UN's Sustainable Development Goals (SDGs)	61.46%	126
Climate and Environmental Change Research	91.22%	187
Disaster Mitigation (Early Warning and Crises Management)	76.10%	156
Urban Management	64.88%	133
Marine Management	46.34%	95
Atmosphere Research	45.85%	94
Marine Research	45.85%	94
Water Resources Protection	60.98%	125
Land Use Investigation	68.78%	141
Agriculture Research	67.32%	138
Forest Protection	60.98%	125
Other (please specify)	9.76%	20
Total Respondents: 205		



Others:

- Public Health
- Food Security Supply
- Scholarly Communication
- Geothermal
- Hot Rock
- Artificial Intelligence

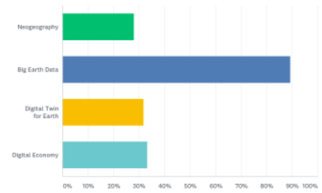
• Education	• Social and Economic development
• Semiotics	• Glaciers
• Philosophy	• LIDAR
• Life Sciences.	• UAV
• Energy	• Planning

- The applications of Digital Earth (e.g. Disaster Mitigation, Urban Management, etc.) require the underlying _fundamental_ data. Hence, I have prioritized the top 4.
- Individual journey
- Sustainable consumption, well-being, future of work
- Human geography research fields (migration, conflict, history, culture); Earth Systems Science (Interactions between all of what you listed above).
- Maybe served as materials in classes of schools
- Actually, I believe Digital Earth could provide valuable support to all fields above. The Scientific Knowledge Building would be fundamental for Digital Earth to provide such support.
- Mining and minerals. As man moves to new technologies, she will need to find more of the critical metals to replace her hydrocarbon needs. Minerals systems are complex, and need complex analysis to discover and recover them.
- General education, knowledge building for general population
- Digital Earth is a new worldwide principle, therefore it impacted whole research areas.
- Almost any Planet Earth studies
- If Digital Earth provides the range of data, and analysis and visualization capabilities that I suggested earlier, then it is feasible that it could do all of these.

Q14 How do you understand the(se) concept(s)? How do you think it(they) should develop?

189 surveyees vote the concepts that they believe it(they) should be developed

ANSWER CHOICES	RESPONSES	
Neogeography	28.04%	53
Big Earth Data	89.42%	169
Digital Twin for Earth	31.75%	60
Digital Economy	33.33%	63
Total Respondents: 189		



And some understandings or descriptions on these concepts are given. To know the full views of their understanding, the raw data is listed below:

- Big Earth Data is related with the generation of free georeferenced data bases with environmental and socioeconomic information
- All are valid, relevant and have potentials. As first step, SWOT analysis should be

considered to elaborate in all cases

- With open-source data and software
- Big Earth Data - data standards and hosting of data;
  Digital Twin- data and models for representation and simulation;
  Digital Economy - virtual industry
- Databases and others Tech for Digital Earth
- Neogeography is about citizen generated contents of the earth's surface;
  Big Earth Data is about voluminous geospatial data from various sources such as satellite remote sensing, social networks, and sensor networks;
  Digital economy is about the economy that is dependent on digital communications (Internet, Data communication etc.
- There should be a global standard applied to ensure greater collaboration and good results of research. And a global plan to support Interoperability will make it happen.
- To acquire the time series, multi-dimension data of/on/in Earth. To manage, analyze and visualize the data. To make the data easier used by the public.
- Use geographic big data, Internet of Things, cloud computing, scientific computing and other technologies to achieve a truly smart earth and finely serve people's work and life.
- This is a complicated matter. I prefer to use the term "Digital Ecosystem for the Planet".
- Interconexion
- Neogeography: a liberate form of (geographic) knowledge creation and sharing;
  Big Earth data: a subset of big data;
  Digital Twin for Earth: an intermediate step to finally think of our reality being a combination of the physical earth and its many digital models - and both keep interacting increasingly;
  Digital Economy: influences of digital technologies (their use, and people's understanding thereof) on the economy.
- Neogeography is emerging in Germany (geo-apps, navigation, Google maps, ...). Investors are skeptical to finance apps (others than navigation). Since four years I am designing and leading a project: https://panature.org/?lang=en. We are targeting UN Global Geoparcs. They all show great interest. But it is difficult to initiate projects as our partners have small budgets. I think this is an example of non-commercial initiatives in Germany.
- I think they are all connected and their developments are inevitable. These 'feed' Digital Earth vision, as the vision should consolidate it all.
- I presume data should be free for the 0eople to access and use in their small projects to further understand this world we're living in.
- Example of big earth data = satellite remote sensing data, continuous sensor observations. Digital economy = enhanced productivity/economic activity through use of digital technologies.
- Be accessible and transparent...
- The faire of digital earth collects various data to support the relevant fields.

- Beyond the currently accelerating Earth observations, Big Earth Data is developing toward the societal implementation. The society value should be what it is aiming to fulfill in the future.
- All of these are 'branches' of digital earth for specific purpose, I think.
- Just learning of theses concepts as they develop College level intermediate level
- I believe that for a big date, blockchain and digitalization are future. The world will gradually come to this. Mine surveying as a science and geography should not lag behind progress to ensure the pace of development of science and technology. It is necessary to use and implement advanced technologies in the development of earth sciences (such as blockchain, automation and others). In my scientific work I try to do this with the use of the entropy approach.
- Big Earth Data will be one main contents or basis of Digital Earth. By the development of DE, more and more big earth data can be analysis and make the decisions more correction and refinement.
- They should be developed taking into the digital transformation, the adoption of new technologies to processing the Big Data collected for Earth Observation.
- More info in order to understand in depth the dynamics of landscape
- Using Quantom computing to handle the rapidly increasing large amounts of EO data
- Neogeography will improve the visualization and understanding of global phenomenon by citizens. Digital twin for earth implies that fresh sensor data is retrieved to update as soon as possible the digital representation of the natural phenomenon. Big earth data means the data management infrastructure that can handle a huge amount of data. There is a huge challenge in managing images. Digital economy is the information technologies economy related to the web.
- By study, by way of big data, cloud computing, Internet of things etc.
- Data with user friendly GUI's
- Neogeography is something that will just happen with better understanding of earth systems, in-part driven by the digital economy. Much of the digital economy is driven by men needs to operate on the earth's surface and (in the atmosphere), not quite a done deal, but atmospheric weather systems are directly observable, and location based services get better and better; neither really are directly related to Digital Earth. Digital Earth needs to go into the subsurface, to better understand the 4D.
- Digital twins, feels like the wrong phrase for earth systems, man builds a digital/analogue twin so he can understand a system (car/building) before creating it; the Earth though is already built. Process modelling would be a better phrase."
- The Digital earth concept when fully implemented will provide an enabling framework to support Digital economy, since locations play greater roles in economic processes. Earth data will therefore be more than being imaginable, and due to complex nature of the globe, enormously huge earth data will be streaming seamlessly
- They should be managed in an integrated infrastructure
- My main belief is that the Digital Earth mission should make a positive difference

to human understanding and behaviors that are critical to a sustainable future

- Big Earth data is the data generated from earth observation. "Big data" means it is very huge in volume and is heterogeneous and may be unstructured too making the process of analyzing and interpretation more complex
- I think Neogeography must be named as Neocartoraphy or VGI. There is an opportunity to have global coverage of vector datasets of GI.

  Big Earth Data is the combination of Digital Earth and Big Data. I think personal Big Data shall be free and open in order to give the same opportunities to all kind of actors, specially private companies. It is not fair that a cmpany giving me a digital servicetakes muy personal data to sell it and to rarify the marketreselling it only to a some actors.

  All companies and public orgaizations must cmplete thier digital transformation, including geospatial transtiion, as soon as possible for being relevant in next future."
- Neogeography was a term coined by Andrew Hudson-Smith of UCL CASA in approx 2006 and his initial experiments were basically in early spherical photography. This term seems obsolete now, or just broadly applicable to a big post-millennial movement in geography.

  Big Earth Data was a term coined by Guo Huadong of RADI and is the title of an ISDE-supported journal but it suffers from the absence of any reference to either geography or streaming data and it emphasises a particular category of data. Big Earth data — at the expense of vital issues like representing and applying data.

  Digital Twin for Earth is a new phrase that applies the increasingly popular idea of digital twinning — the old 'simXXX' and BIM for architects concepts – to the scale of the planet.

  Digital Economy is a system-subset within the Digital Earth vision that will be enabled – and transformed – increasingly by blockchain processes. Because today's most credible sustainability concept diagrams (as used for the UN SDGs) place 'economy' as a smaller circle inside circles representing the earth and humanity, this term should be treated with caution. Economics is a political system, an expression of human interactions; it is not itself a science."
- I think there is too much focus on terms and definitions, its all aspects of the same process. Development should focus on broadening use through conceptual and computational elegance i.e. solutions which rely on complex frameworks and the brute force of high energy consuming super/cluster computing facilities should be restricted to the most essential use cases.
- Quick simulation of global changes
- They should be developed considering ethical issues. People info should be protected as well as some sensitive analysis. Imagine someone found how to know where tuna fish is at the time. Should be sharing online?
- Neogeography is a Digital Earth-based geography; Neogeography is an implementation of Digital Earth vision into geography domain. Digital Economy is a current attempt to overcome limitation of the classic scalar-based economy. Neogeography & DE are vital for Digital Economy as an virtual twin of real Earth,

immersed in virtual ecosystem.

- Collecting data from sensors
- It will absorb all kind of data from different platforms and sensors.
- Because BED contains structured and unstructured data and GISs can easily manipulate and visualize structured one, the challenges are going to work, analyze, generalize and manipulate with unstructured data.....
- Neogeography should use human-centered design to facilitate the use of smartphones even more to engage users in data collection though offering smart services
- The main issue is that Digital Earth should continuously observe how these technologies evolved and to assess if they can be used for Digital Earth"
- Integrate multi-source earth observation data, carry out scientific research inside and outside of the earth, promote the development of Earth Science and regional sustainable development
- To understand, model, map, and monitor a wide array of Planet Earth parameters over time and space, repeatedly and continuously in many different spatial, spectral, radiometric, and temporal resolutions
- Neogeography is basically the use of geographical tools by non-experts. Certainly, that is desirable and presumably would be part of Digital Earth. The nature of the interface to Digital Earth might need to be different for this group of users. I have read a bit about Big Earth Data and Digital Twin for Earth.
- These represent individual epistemological paths towards fused/integrated automated systems for the understanding, description, and engagement with societal sectors.
- The first two are used indiscriminately and are largely outdated. The third corresponds with my vision for Digital Earth and the fourth is simply a reflection of the context in which we now live our lives.

Q15: What do you think is(are) the greatest challenge(s) that Digital Earth is likely to face in the future?

ANSWER CHOICES	RESPONSES	
The severe mismatch between the processing and storage needs of the escalating volumes of data available, and the need to have a sustainable energy footprint	56.57%	112
The reshuffling of the power relationships among government departments, space agencies, private companies, and civil society	58.08%	115
The ethical (privacy) and security issues	46.97%	93
Other (please specify)	16.16%	32
Total Respondents: 198		

Others:

- Bringing the computing to the data. Otherwise, importing data into cloud computing resources is a significant bottleneck.

- How to ensure preparedness for the uncertainties, unpredictables and special situations
- How to get the Earth information out from the big data. We need a lot of new tools.
- From a technical perspective, managing the variety of data; of the four dimensions of Cloud Computing for climate science, the "variety" is just as much a challenge as volume and velocity. In the context of climate change data and computing, "veracity" (truthfulness) of the data is extremely important.
- Digital solutions for public and private sectors
- Holding up to the many faceted expectations, while at the same time being not widely recognized as an embracing concept and solution provider. Mainstream developments are too often fed into the Digital Earth Vision instead of having Digital Earth really influencing the global scene. Only few parts/facets of Digital Earth are being mainstreamed (most recently the Digital Twin).
- Privacy and data protection has to improve further.
- It is an extremely ambitious idea and it has a very large list of challenges. Current biggest may be still the technological ones, but I believe they will be solved given the progress tech is making. Once the information is storable and reachable ""centrally"" then will come the politics. Who owns the data, and who will have access? Since it is very powerful, there will be a lot of issues about power, control, ethics, privacy, security. One thing you did not list which I believe will be an important factor too is the human factors in its usability, accessibility etc. The needs of everyone is different at different ages, professional backgrounds, roles, and interfaces should be made available to them all, ideally.
- Tata transparency
- Interoperable data
- Data availability!
- How to ensure that DE is inclusive and allows access to even the most disadvantaged.
- The improvement of the fundamental understanding and physically-based modelling of the processes governing the climate System and its various components, and the integration of the process understanding and (geo-)physical models with big data and AI.
- The data is needed to meet global grand challenges.
- Data - analysis - sustainable decisions
- Data is power. Depending of the type of data that people can access, you influence the society. It is quite dramatic that actually the science is not true by the society. The society thinks that scientists are as much liers as politicians. Some government still say that there is not climate change. How it is possible?
- Probably part of 'power' issue, above, but money, or rather a long term commitment to maintaining systems once developed, and continuing openness of data and standards.

- Organization across different levels of hierarchies working in silos
- Citizen engagement and action
- Lack of intentions by government bodies and lack of funding is a very challenging to mitigate the climate change.
- The use of open data, open services and open standards n he context of business models accepted by private companies.
- —geopolitical machinations
  —lack of broad outreach or inclusion (realities are different from rhetorics)
  —insularity and cliquism among scientists
  —hacking the systems and skewing the data
- Inequalities in access to information and the skills to use that information.
- Trust in information / information production
- Implementing open data / access policies to facilitate access for everyone
- Human phenomenological understanding of spatial/ environmental phenomena
- Insufficient coordination of countries and agencies to develop the systems needed to acquire needed comprehensive data. Lack of sufficient support to achieve the full potential.
- Digital Earth contradicts with current decision making architecture on all levels - global, local, and special. It is temporal, but serious challenge.
- Funding! Digital Earth needs to show that it is becoming a reality and that it can support decision makers, society, towards sustainability.
- Availability and access to free data and affordable computing. Also sufficiently trained experts
- Regarding item 2, I would suspect that the different political environments of some countries could make data sharing problematic -- this would be a critical problem as data sharing is integral to a truly open Digital Earth.
- Co-opting of DE advances by distinct, and sometimes isolated, business-science sectors where the prime directive is profit making in capitalistic construct. DE will need to be recognized, somewhat like the Red Cross, for its value to humanity (albeit the Red Cross is money making enterprise) and not Wall Street profit margins. DE may experience the dilution of its influence with governments, academe, business, and society as the technological advances become mainstream in society, e.g., geo-browsers. Especially challenging will be to blend the DE framework with evolving social-media memes and campaigns without loss of the original DE Vision.

Q16: How would you foresee the future of Digital Earth in the next ten years?

139 surveyees provide their views on the future of Digital Earth. The raw data is listed below:

- With a great amount of available information, but with a few researchers capacitated to use this
- Promising if the exploited and applied technologies successfully contribute to the implementation of the sustainable development goals, e.g. to health or food security as well as to the Paris Climate Agreement and Sendai Disaster Risk Reduction Framework. DE technologies should support the good governance via analysis ready data and knowledge gained from multidisciplinary expertise to ensure informed decisions for the benefit of the communities involving the citizens/NGOs and based on the private, academic and governmental collaboration in partnership.
- Digital Earth will be the most important scientific and technological foundation of the future intelligent city or society.
- Based on the creation of a digital charter convention that protects citizen privacy, and ensures best practices of data governance; a Digital Earth could be achieved through public-private partnerships. The infrastructure is already created, is fully functional and it just needs to be harnessed towards the advancing of common goods. This requires high-level political engagement which is currently lacking very far behind the advances of the digital technology.
- Coverage gets comprehensive
- More complete model at various scales.
- More and more applicable in society
- It will continue to promote academic exchange, science and technology innovation, education, and international collaboration towards Digital Earth.
- Greater emphasis on security for some aspects
- More use in decision making
- Greater development to realize this project
- More stakeholders contribute more data to manifold instances of digital earth systems, which make grasping the available information a challenge. Proprietary data and closed systems are a severe blocker for innovation and collaboration.
- Tremendous progress and trends
- The synthetic models integrated from different disciplines would be popular.
- It will develop in a moderate speed. In ten years, we may be able to see some platform that can primary service for science research.
- More international cooperation, which is why the work of ISDE is important.
- Data expression for Earth
- It’s awesome and interesting to forward to.
- By creating awareness
- Data will be a commodity that will push the drive for the generation of quality data. This would lead to development of robust and sustainable models to enable digital earth.
- Useful for the society
- Significant developments relating to big data, machine learning, deep learning, parallel computing, and free access to data.
- The open source platforms and scientific groups should play more crucial roles.

- There will be a great revolution
- New services for the human being
- Move towards AI
- Smart Earth is destined to become the mainstream culture of people.
- Significant development in analytical techniques and sensor technology, plethora of data, multidisciplinary groups encompassing academia, computer experts and end users. But the chances are that developing and underdeveloped world will remain far behind the developed nations in the final execution and implementation, primarily due to lack of expertise, political apathy, and lack of integration among the technocrats and stakeholders.
- Boom times
- Taking a general viewpoint, there will be ever more open data available; the main challenge is for developing nations to learn to use new analytical methods to explore these large data sets
- I anticipate a great development of research around the concept of Digital Earth
- It could be bright, if it succeeds connecting to and showing its power for addressing global challenges.
- Accessible and multi theme
- Thanks to the rich remote sensing data and the rapid development of artificial intelligence technology, digital earth will make substantial progress.
- Impossible, artificial intelligence and pattern recognition
- With the advancement in technology and the internet, data access should significantly improve to institutions that use it for research.
- Use of AI for data integration/presentation.
- I think it'll be a huge leap. Next 10-20 years should have a really big impact on any field driven by technology. I also see that a usable implementation of what we envision may have relevance on understanding and potential for mitigation planning for climate change.
- Great development to more detailed information
- Digital Earth data should be disseminated whenever the research people are required, can be accessed through the login id and password, it should be free from achieve.
- Data sustainability
- Undoubtedly, it is flourishing but major concerns would be that of the privacy and cost-effectiveness
- I see a huge gap between the user community (public) and the tec developments. There has a knowledge gap to be bridged. I think the technical innovations will be implemented, but the process is very slow. I think digital earth technologies and IoT will be a very huge market.
- It will become a platform for geoscience research.
- Strong platform
- Improvements needs to be done. With correct model, in the ten years Digital Earth can be completed.
- Improving in data integration and visualization

- Struggling to find solutions to problems and stuck in data ...
- Techniques in sensors, computation capabilities and data communication will be rashly developed
- Exponential growth
- DE is essential to meet the challenges faced over the coming 10 years, however progress is slow.
- A prototype of the Earth digital twin is operating
- At present, the Digital Earth framework is relatively complete, but hasn't been pushed very well. For instance, many working groups are majoring in the similar researches, which is the waste of time. In the next ten years, tasks of each working groups should become much clearer and things would be pushed well. More and more people, who do not work in the relevant fields, while know the concept of "Digital Earth". We can search information we wonder at home easily.
- A heavy focus on computational development: AI/machine learning
- I am going to contribute with research on Quality of Life -> from the human perspective to find a consensus between earth and human needs
- Bombing of the analysis velocity and resolution
- Digital Ocean will be paid more attention as the global change.
- Digital Earth will contribute to advance our understanding and quantitative study to the earth
- Rapid growth of applications and growing ethical challenges and concerns in managing and regulating DE usage.
- Great improvement of digitizing, more visualization of areas hard to reach (in situ areas)
- Transition of companies to digital and automated mining support. Decentralized and generalized digital land database (using blockchain tools)
- It will be used in more applications
- Based on open access, and participation across multiple technological platforms, and media. Not one Digital Earth, but multiple connected globes/infrastructures addressing the needs of different audiences: citizens, communities, policymakers, scientists, educationalists. Enabling access to data, information, services, and models as well as scenarios and forecasts: from simple queries to complex analyses across the environmental and social domains.
- From data storage to phenomena analysis
- Satellite revolution: nanosatellites
- In the future what I expect from Digital Earth is that it be focused in the field of research to facilitate the acquisition of environmental data
- Very important for global future if it includes all those items
- Accessible
- A lot of data, a lot of science but little political implication
- Rich of information acquired in situ by satellites/airplanes free available to study the earth
- Up to the younger generation to determine this!
- Explores the big data technologies and capacities for largest, multi-temporal

analysis globally.

- It's very promising, but More Things to do.
- A big chasm between few GAFAM who manage IA and Big Data and scientific community need able to do it.
- Exploding
- Would reach everyone in the society through location based services
- It is hard to anticipate, and even harder to phrase a unique vision. Local differences are expected. For example, the disclosure of sensitive information is not an issue for all countries.
- An interactive virtual earth is the first objective.
- It will reach high achievements in the fields of earth science.
- I am hopeful but skeptical that Digital Earth research will help ameliorate the forthcoming effects of Global Climate Change/Global Warming but am concerned that this is a Political Issue driven more by economics than science and/or common sense.
- Exponential growth of available data
- Digital Earth will have to develop sustainable partnerships with related initiatives rather than develop discrete programs
- 1) Participatory 2) Move to open science
- Ambitious and promising
- There is impetus now, lets' start thinking about how to be as open and flexible as possible, and build to evolve. It might just work...
- Increasing Building Technical Expertise
- Interesting, solving global issues - anthropogenic and natural
- It all depends on politics ...
- I really hope that governments will efficiently use EO data and embed them in evidence-based policy making practices
- Service and pilot exercise
- Development of AI methods for remote and in situ sensing time series analysis
- The development of IoT and 5G&6G will massively increase observing data of the earth, real-time processing and analysis of them will be a big challenge.
- I would like to see it take a greater role in tackling social and environmental challenges related to our planet
- It will become one of the core subject to do research
- It will be benefited from IT and AI.
- Gradually improving. More focus on knowledge representation and AI.
- I think there will be an enormous step ahead and Digital Earth will evolve more and more to match Al Gore vision a little more.
- Replaced by another term championed by another internationally popular thought-leader succeeding Al Gore. Noting that the Group on Earth Observations already supervises the Digital Earth vision under its program name (GEOSS).
- More advanced and influential in decision making process
- It will become a vernacular part of life.. unfortunately this will probably place tremendous power in private providers of the infrastructure which runs it

- It needs to become ubiquitous and a well-known data integration/processing system such as GIS.
- Will be increase solutions
- Challenged by increasing disruption through censorship and nationalist movements acting against an open society
- There won't be much progress. High speed data sharing will be the key.
- Great enthusiasm, but preoccupied how some applications are or can be used.
- Digital Earth should be adopted worldwide as a new geocentric philosophy for mankind instead of previous map-based one due to shift of paradigms in geospatial domain.
- Free and easy access of high resolution data
- Integrated all science fields
- I expect intensive developments on hardware and processing parts
- Big progress
- Continue to grow and prosper
- To help BED manipulation, to be in help of the society for managing natural disasters, terrorism, epidemics, climate changes, etc....
- Real-live applications in smart environments
- I foresee "Digital Earth as a system of systems enabling improved understanding of the complex interactions between humankind and the Earth ecosystem. A user friendly interface should allow decision makers to monitor their policies"
- Rapid development and change of the world
- Fantastic. It has wonderful future in entire century and beyond
- It is conceivable that it could reach Gore's vision if people around the world work together.
- If DE doesn't claim the mantle for addressing climate change with the Greta-generation, DE will lose relevance outside selected research environments.
- This is a challenging time since there are many ways to conceptualize and implement the vision and collaboration and consensus will be required to make measurable progress.
- Will develop quickly and into our lives.

Q17: If working groups under Digital Earth framework will be built up, which working group(s) do you want to join and contribute to?

Near 80 working groups are proposed by 138 surveyees*. Below are those they would be interested in and like to join and contribute to:

• Theory of DE • History of geospatial domain • Earth Observation • Processing and analysis of remotely sensed satellite data	• Climate and environment research • Climate change security • health-related • Urbanization and population mobility

• Satellite sensors • Algorithm developing • Neogeography, novel insights and innovative technologies • Spatiotemporal modelling combining accessibility, transportation, location, population, medical telemetry, food security, climatic and other relevant or applicable data (eg. neogeography and social media) to support informed decisions. • Governance and policy design • AI and machine learning • Computer Science and artificial intelligence • Spatial analysis • Spatial skills development • Geosciences and Images processing • Spatial Data Infrastructure • Semantical integration in SDI • Altimetric data • Data platforms • Data fusion • Data science • Data standards • Data processing • Open data • Open services and standards • Data expression for Geology and Earth surface • Flexible interoperability frameworks • IoT • Sensor frameworks • Digital twin of Earth • Digital twins of regional environment • Addressable spatial unit frameworks • Social media • Geodesign and end user interfaces • Intelligent processing of Geospatial Big Data • Big Earth Data	• Urban management • Urbanization and environment • Urban and regional planning • Smart city • Climate protection in the urban area • Water resource • Digital Water • Land use/Land use planning • LULC • Land degradation • Land and soil • Digital Earth for UN sustainable development goals • Ecohydrology • Ecological security • Digital Ocean • Ocean science • Coastal and ocean management • Marine spatial data infrastructure • Meteo-marine research • Atmospheric research • Citizen science • Crowdsourcing • VGI • Digital Earth on Geological Environment and Geohazards • Agricultural • Food production • Food security • Natural Hazards • Rapid response to global disasters • Disaster Mitigation (Early Warning and Crises Management) • Measures on disaster mitigation • Crises management • Disaster reduction emergency • Wildfire behavior/monitoring • Collective Intelligence for public good • Spatial information for sustainable development • Human factors (in visualization, interfaces, interaction & extended

• Modeling and simulation • Geospatial thinking • Geoscience-GIS-Remote sensing. • Digital Earth data sharing and management • Surface Monitoring and Evaluation • Fusion of volunteered geo-data • Discrete global grid system • Geographic Information (GI) • Ground base comprehensive observations • Earth Monitoring variables • Geomorphology • Geo-visualization • Observation capacity building • Transparent and reproducible workflows with Digital Earth (Open Science, Reproducible Research, Open Reproducible Research)	reality) • Landscape management and assessment • Scientific publication • Cryosphere • Forest science • Carbon cycle • Environmental and societal resilience • Ethics • Cultural Heritage Digitization / Prospection • Education - Research and training • Pedagogically implanting DE into education sectors (K-12) • Minerals systems • Hydrography • High mountain • Polar cold area • Agriculture production modeling • Tropical agriculture and forest changes

* The ESA Climate Office would look forward to discussing further.

Q18: What challenges are you facing in your work/research regarding Digital Earth?

More than 100 concerns that challenge their research work are proposed by 150 surveyees.

- Sustained funding, time, energy and mobility
- Is it worth striving for?
- Vagueness of DE concept
- Digital Earth need global vision, while technique is develop slow
- Not being involved
- How to convince people
- Continuity of programs
- Computational power to process the available information, large volumes of data and time series data.
- Computing Infrastructure (Hardware and Software)
- Computational complexity
- Currently technological limitations seem much to do with human computer

interaction
- Limited computer power and storage resource
- Lack of standards, governance and policy, and low engagement.
- Lack of Interdisciplinary/Multidisciplinary Research Team
- Lack of cooperation from the non-academic organizations
- The big data handling of huge amounts of satellite data and the information extraction and data dismatching
- Manipulate with big data
- Data sharing and open access
- Data (geodata and source codes) sharing
- Big data management
- Data accumulation and expression
- Data and accuracy
- Data standards
- Data quality and consistency
- Reliable data on urban and transport infrastructure, including altimetry
- Severe lack of accurate socio-economic data Lack of ground data
- Data integration from multiple sources
- Intelligent processing and mining of earth big data
- Data availability, particularly reference data
- Free availability of in-situ data
- The availability of data able to catch the changes in a rhythm proportional to the one of their occurrence, yet at the proper spatial scale (e.g., Urban Atlas data have a good scale, but are updated too rarely)
- Data storage and processing, availability of historical remote sensing images like Landsat images
- Reliable and serial data
- Lack of data in registration earth phenomena (natural and provoked disasters, early warning criteria)
- Short of open data sources
- The global data for regional spatial planning
- Lack of high time resolution remote sensing data
- Availability of data at the city/district level in the region
- Access to fine resolution remotely sensed data across global and regional AOI
- Access to affordable data in data poor environments - cities in global South.
- Processing and storage
- Hard to keep track of existing work, proprietary or not open data and software prohibit re-use and improvement.
- The inconsistency between the space and temporal resolutions between different sources of data
- Access to marine data, big storage space required, difficulty in processing big data
- Understanding the full scope and potential in context to climate change
- Lack of policy and safeguards on how to partner with private sector
- Lack of standardization.

- Access to data at a finer scale and lack of standardization
- Satellite data show great glacier melting from 2000 to present but we have much less data for reference period 1961-1990
- Big Earth data storage and analysis
- There are many programs and how to correlate between them
- To study the impact of new modes of representation of the territory on users in the fields of: geospatial thinking, interpretation and representation of 2D / 3D terrain and new paradigms of teaching of geographical sciences
- Forest fire prevention and management
- Soil science
- AI and machine learning related data processing
- UAV or Drone image analysis
- LIDAR Survey data processing
- Processing time, high resolution/high-cost and vice-versa, data availability, hands-on -training to newly introduced techniques
- Rapidly developing technology.
- Not having enough knowledge of software knowledge ...
- Connecting technology with people.
- Timely adaption of the rapidly changing technologies
- Digital ocean group has not been established
- Simulating of regional development
- To identify the unique feature of Digital Earth as a discipline of "Digital Earth Science"
- An increase in the accuracy and quality of measurements, an increase in the processing rate and, as a consequence, in production volumes. In research, this digital earth simplifies many operations and calculations.
- little supports by Government and Academic organizations
- Crop Monitoring
- From high resolution images to information on urban Africa
- Machine Learning, Deep Learning, Cloud Computing
- Research regarding the atmosphere and dust aerosols
- Clouding computing, AI
- How to use Big Data in Geography to map at the pixel scale land use change on the earth...
- Visualization of an abstracted earth
- Lack of interoperability with a variety of different initiatives
- Access to platforms (costs) and management understanding
- Everyone wants to build their own silos
- Department working in silos
- Interoperability
- Human capacity training and re-training
- Satellite image processing
- Land use change detection
- Scaling up of solutions/applications

- Use for policy/decision support
- Infrastructure need to use the common societal infra, and need to produce more standards
- Forecasting models and computation in the cloud
- The disconnect between my background and disciplines and the specialist nature of geoinformatics
- To make Digital Earth idea and model and SDI paradigm compatible and synergic
- Obstructions, sabotage, usurping, discrediting of my AU government-funded professorial roles to catalyze a national and global digital cities network
- Big data analysis
- Making models simple enough
- Ensuring longevity of solutions with technical progress
- Calibration
- No clear definition
- Few education materials
- Conceptualization of Earth Surface Phenomena
- The lack of ground evaluation when using some derived products of remote sensing
- Vicious reaction from the old research community in my country as a response to crisis in geospatial domain
- Lack of scientific discussions
- Mostly hardware limitations, in some cases not finding suitable algorithms or methods to handle big geospatial data
- We continue with advances in Remote sensing and Photogrammetry but I do not see yet the Digital Earth platform where these and many other sciences and technologies will be integrated
- Infrastructure
- Modeling of the rock properties, rock behaviors predictions
- The conundrum of geometric expansion of DE knowledge and capacity within exponentially increasing crisis framework

Q19: The scientific book - "Manual of Digital Earth" has been published by International Society for Digital Earth and Springer in 2019. Please let us know what you think about it.

164 surveyees (50%) are aware of the publication of Manual of Digital Earth, and 90% of them have read it. The feedback are listed below:

- Great! /Great work!/ Very good./ Excellent/ It is pretty good./Excellent and timely/ Great book/ Great and useful work!/ Interesting
- Useful, hope to continue.

- It is a milestone.
- It was published in time
- Very useful publication.
- I like its forward looking chapters. The book has been promoted and advocated at ISDE11 report and at highly relevant domestic conference in November. Will be promoted again asking for comments from the local community here in Hungary."
- I think this book is very important for international research field of Digital Earth.
- This scientific book should be disseminated more widely, since a high percentage of the cinematic community and the population in general, ignore the result of the book.
- It is great initiative to provide knowledge on multi-disciplinary topics in Digital Earth
- It provides a good reference for the researchers.
- It’s awesome and addresses the needed technologies and gives a brief about everything that relates to digital earth.
- It is an excellent read which covers Digital Earth concepts in breadth and depth
- The book provides detailed instructions of some research topics
- Excellent monogram of the compilation of the various salient issues interfacing the concepts and applications in the domain of digital earth.
- Of course, it is a good thing in the industry, which helps the popularity and development of digital earth technology.
- It is a reference document in my research, in which there are very interesting works by leading researchers in the field of digital earth.
- Big community effort. Reflecting well where we stand as a society.
- I think it is good for implementation of big data
- It's a great initiative and a useful book!
- Good and appreciated work done by the Digital Earth scientific committee.
- It is quite useful materials for workers on DE
- I have just now taken a look. It is long but it seems to cover many aspects related to the digital earth ecosystem
- I am interested in remote sensing and climate change ... I was able to examine here ...
- it is a good guideline for the development of digital earth
- This is a helpful book, especially for researchers and students who are working in the relevant fields. I specially like the Chapter 1 "understanding digital earth". It gives us a whole and clear concept about digital earth, although it doesn't occupy too much space.
- It is a very good document.
- Comprehensive and updated
- This is a great book for promoting the Digital Earth worldwide, and a great contribution from ISDE
- Very informative, touches basis on concepts of what we have learned in college level courses
- It is a very good thing to the digital earth development.

- Very good synthesis up to date on the subject
- It's a good thing because it helps guide the public in the site in their quest for data
- Excellent. It should be a basic textbook in all university courses on geography, environment, natural resources, computer science, etc.
- The principle "authors pay", if applicable for supporting open access, is beyond the funds of many scientists
- It's a great job that summarizing the key achievements in Digital Earth and also providing a systematic analysis of the theories, methods, and technical systems of Digital Earth.
- I am impressed. Good job.
- It is an important commitment to promote knowledge
- Just skimming the contents... Discrete global grid systems, don't work well in 3D, that's a problem to solve. Semantics and ontologies are mentioned in sections, but I would expect a full section devoted to them. AI and machine learning might work out the semantics eventually, or we could give them a 15 year head start.
- Not aware of it before, a quick glance reveals it to have interesting chapters written on topical issues by seasoned scholars and edited by three unique scholars. Being on Open source ought to make it globally accessible by all for all.
- First, it is free of access, so far great! I will take a deeper view into the book and I am sure it could give me a comprehensive overview of the technology and development progress in the area of digital earth. A good guide book.
- very nice and innovative
- Nice initiative, will have a look.
- This is a great resource to understand what has been done so far and what are the true benefits of DE.
- It is a development stage for our world.
- It is a good reference of our research.
- fundamental book both for researchers and students
- It is an excellent work. I already studied the remote sensing part (chapter 3), 10, and 11. It provide useful information.
- But, I would suggest how can we make it accessible to the whole community at no cost? Many people have no research funding where they want to do something, but due to lack of resources they are unable to do their research."
- It is so a big book that I don't have time to finish reading it completely. However, it is one of the good contributions to digital earth research.
- It is a fantastic resource.
- This is a very important anthology of scientific papers but a lot of them seem to have been written by emerging academics who are not necessarily the best international experts for each chapter.
- It summarizes very well the state of the art of digital earth
- Have not got a chance to read it
- Please make more publicity of this book"
- It is good, but there should be a short version (e.g. 10 pages summary) available

as well. The chapters are of varying quality.

- Great reference frame
- It is a comprehensive, useful reference.
- It is a pivotal book with worldview significance. But it is not finalized, of course. I propose to publish something like Annual Almanac "Manual of DE: 2020 results" for constant updating DE Vision.
- I have just learned it from this survey. I only check the contents and chapter topics are very well selected. I will read it in detail/
- The book is great and pretty useful
- I commented already when the Manual was announced.
- I have not seen this publication
- In the process of writing the book that I mentioned earlier, I have read several of these chapters and found them quite useful.
- The first chapter is brilliant. The Manual fills in many important sectors and issues within the DE community.
- A quick review of table of contents suggests a wider array of authors might have been solicited for this project.
- It helps a lot to understand the Digital Earth.

Q20: Do you want to be informed about the outputs of the workshop on "Digital Earth Vision Towards 2030"?

ANSWER CHOICES	RESPONSES	
Yes	87.70%	164
No	12.30%	23
TOTAL		187

Q21: Do you want to be involved in more ISDE activities in the future? If yes, we shall add you into the ISDE mail list.

ANSWER CHOICES	RESPONSES	
Yes	84.57%	159
No	15.43%	29
TOTAL		188