

Development Co-operation Directorate
Development Assistance Committee

DAC Working Party on Development Finance Statistics

SATELLITE-BASED ENVIRONMENTAL INFORMATION IN SUPPORT OF DEVELOPMENT AID PROGRAMMES & PROJECTS:

**Examples from the European Space Agency (ESA) collaboration with key International
Financing Institutions (IFIs)**

**Formal meeting of the Working Party on Development Finance Statistics (WP-STAT)
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**This paper is an INFORMATION NOTE prepared by the European Space Agency (ESA) with
examples of ESA collaboration with key international financing institutions (IFIs) and the use of
Earth Observation in the field of development aid.**

**Under item 11 of the draft annotated agenda [DCD/DAC/STAT/A(2018)2], the Secretariat
recommends that contributions to ESA's programme "Space in support of International
Development Aid" be reported as bilateral ODA; see DCD/DAC/STAT(2018)35.**

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Satellite-based environmental information in support of Development Aid programmes & projects : examples from the European Space Agency (ESA) collaboration with key International Financing Institutions (IFIs)

Article for OECD, June 2018

(prepared by the ESA EO4SD team, eo4sd.esa.int)

Development Aid

Development aid and finance is a complex and rapidly changing international system covering a range of assistance from the developed to developing countries.

This international system consists of many diverse institutes and organisations, including the International Financing Institutes (eg. the World Bank, Asian Development Bank, etc), the National Aid/Development Ministries and Agencies, the European Commission (DG-DEVCO) and the private sector (eg. the Rockefeller and the Gates Foundations, etc).

The OECD Development Assistance Committee (DAC) was established in 1961 to set global standards, monitor development assistance finance (whose core is Official Development Assistance - ODA) and advise its member countries on appropriate development policies. Most ODA comes from the 30 members of the DAC who have a commonly agreed target of ODA to reach 0.7% of donors' national income (GNI). Over the last two decades, the level of DAC member countries' ODA financing has more than doubled and reached \$146.6 billion in 2017.

However, there is increasing institutional and public interest and pressure on accountability, transparency and environmental sustainability within the development aid community. One concrete manifestation of this is the definition of the Sustainable Development Goals (SDGs) in 2015, which will drive the eco-system of development over the next few decades. In support of the 2030 Agenda for Sustainable Development, the OECD advances key issues on development finance through data collection and reporting, establishing statistical measurement frameworks, and analysis on a variety of development finance topics.

In addition, significantly more attention is being paid to the consequences of climate change as a threat to global development with the poorest and most vulnerable countries being hit the hardest. All IFIs have comprehensive programmes and financing in place to help developing countries become more resilient to the possible effects of climate change and the impact of associated extreme natural disasters.

These factors (sustainable development, climate change) are driving the IFIs to improve their knowledge of the current state and future evolution of the Earth's environment through new, innovative information sources and technologies. This is the role and contribution that Earth Observation (EO) Satellites can make.

Earth Observation

Many significant developments and changes are taking place in Earth Observation that are

bringing this technology from a largely scientific use, to a level where it can be used as an operational source of environmental information in non-specialist domains. Major elements include:

- The progressive deployment and operations of the EU Copernicus fleet of satellite missions, providing unprecedented volumes of free and open EO data, and the complimentary capabilities offered by the increasing number of VHR Optical and Radar National missions,
- The advent of 'NewSpace' with the entry of the private sector through the development commercial Small-Sat massive constellations (e.g Planet) and the projected large growth in these types of missions over the next decade,
- The rapidly evolving ICT conditions (cloud, massive computing, data analytics) and the entry of ICT giants (Google, Amazon, SAP) providing easier access to EO through the platforms that they already operate.

These factors are revolutionising the applications of EO-based information and are opening opportunity to expand the use of EO beyond the traditional largely public-sector (government) user communities, with an increase in Business-to-Business markets (Agriculture, Oil & Gas, Retail) and the prospect of Business-to Citizen markets through social media.

In addition, political, public and scientific interest is growing to make better environmental decision-making through the use of EO to address the grand societal challenges that the world is increasingly facing, as manifest through initiatives such as the Group on Earth Observations (GEO).

Initial Activities & Experiences with EO & Development Aid

Over the last decade, a number of space agencies have started initiatives to demonstrate the capabilities and use of EO in the field of development aid with varied stakeholders. These include the IFIs, national aid ministries/departments, aid agencies/organisations and a range of local government organisations in the developing countries as aid recipients.

A few examples include:

- The Committee of Earth Observing Satellite (CEOS) Global Forest Observations Initiative (GFOI) with GEO and national governments in support of REDD+ national forest monitoring systems for Measurement, Reporting & Verification (MRV) compliant with IPCC guidelines,
- NASA SERVIR joint venture with USAID to provide state-of-the-art, satellite-based Earth monitoring, imaging and mapping data, geospatial information, predictive models and science applications in more than 30 countries,
- ESA collaboration with World Bank, IFAD and ADB, to provide tailored geo-information solutions for a range (60+) of specific projects under implementation,
- JAXA collaboration on space applications with ADB in a range of projects on Agriculture, rural statistics and sustainable development,
- DG DEVCO and JRC initiative on GMES & Africa in the context of the Africa-EU partnership,

- UKSA International Partnership Programme (IPP) using space knowledge, expertise and capability to provide a sustainable, economic or societal benefit to undeveloped nations and developing economies,
- Netherlands Space Office Geo-Data for Agriculture and Water (G4AW) programme to improve food security in developing countries by using satellite data, commissioned by the Dutch Ministry of Foreign Affairs.

Some specific examples from the ESA – IFI collaboration

1. Analysis of Land Subsidence in Jakarta, Indonesia (World Bank)

Background

Jakarta is highly vulnerable to the impacts of natural disasters. The greatest risk facing the city, one that imposes very high human and economic loss, is flooding. Located in a delta of 13 rivers Jakarta was subject to severe flooding that took place in 1996, 2002 and 2007 and inundated more than half of the city. These disasters revealed that the improvements to flood control system are necessary. Existing drainage systems capacity is insufficient to effectively tackle the impact of weather events, the poor solid waste management exacerbates the situation and the rapid land subsidence, largely caused by ground water extraction, is aggravating the problem.

Particularly in the north part of the city the subsidence trends are making local communities extremely vulnerable to sea-water intrusion and coastal flooding. World Bank studies conservatively estimate that land subsidence in Jakarta is occurring at an average rate of 5 cm per year. Recent studies however found that while typical subsidence rates were 7.5-10 cm a year, in localized areas of north Jakarta subsidence in the range 15-25 cm a year was occurring, which if sustained, would result in them sinking to 4 to 5 meters below sea level by 2025. This problem will, consequently, require major interventions from the government, such as increasing pumping capacity, sea wall revitalization, and other macro-infrastructure investments in sea defence.

To address the situation, the World Bank in collaboration with the local municipal government DKI is currently implementing a flood risk management project in the Jakarta's metropolitan area. This mainly includes, revitalization of the Jakarta drainage canals but also a collection of detailed geospatial information concerning flood hazard (past floods, sea water intrusion modelling, etc.) together with an assessment of the existing capacity of the hydraulic networks and investigations of land subsidence patterns. Particularly regarding the latter there is a need to assess more accurately the subsidence rates in the urban and peri-urban areas to plan more effectively the types of investments needed for flood defence.

Results

Earth Observation provided precise terrain motion mapping using radar sensor data that were processed through the Persistent Scatterer SAR Interferometry (PS-InSAR) technique. This offered a unique insight into past subsidence trends as well as state-of-the-art tools for monitoring of present and future terrain deformations.

Very High Resolution (VHR) COSMO-SkyMed data were gathered over the six months' period from October 2010 to April 2011 that yielded very high spatial and temporal density of measurements in the specific constructed areas. In particular, this technique and data has provided information on the land surface displacement on an unprecedented level of accuracy and detail; i.e. more than 5.6 million individual measurement points over an area of 1300 Km², resulting in a density of 4330 points per Km².

The results indicate that the sub-districts of Penjaringan, Cengkayang, the South Center of Jakarta and the suburban district of Cikarang are affected by strong subsidence rates. In the Jakarta Bay district of Penjaringan (see Fig. 1), where water draining channels, canals, and water reservoirs protecting the land from sea flooding are located, the maximal subsidence rate detected is more than -15 cm/yr, resulting in a deformation of more than -60cm over the period of 4 years. In Cikarang, the capital of Bekasi Regency and one of the biggest industrial estates in Southeast Asia, the detected deformation reaches -7.5 cm/yr.

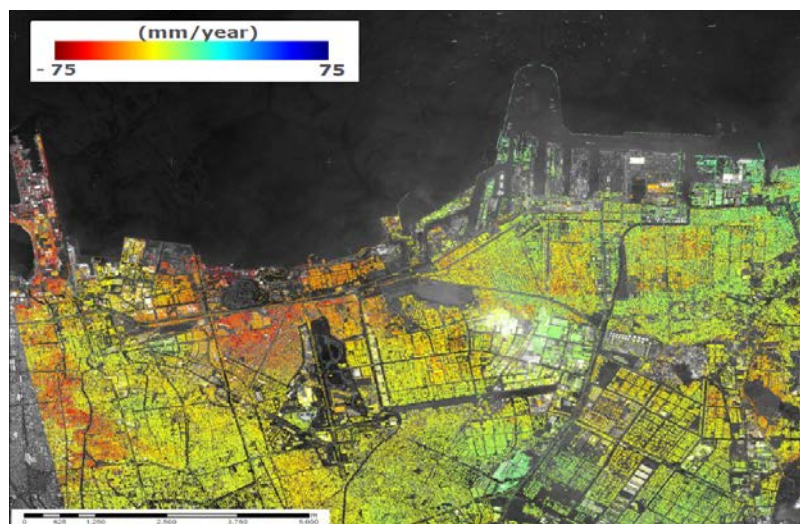


Figure 1 : Colour-coded Land Surface Deformation map in Jakarta Bay and harbour derived from the PSI analysis of VHR COSMO-SkyMed data (Oct. 2010 – Apr. 2011). Credit: Altamira information.

Based on this very detailed information, an analysis of the causes of land deformation was conducted in cooperation with the Bandung Institute of Technology, which has studied and analysed land subsidence in Jakarta for more than 20 years. The preliminary assessment shows that the main cause can be correlated with the extraction of underground water through deep wells that large scale developments and small residential communities alike drill to compensate for the lack of access to piped water. 20% of such wells are over 100 meters deep. The continuation of this thematic analysis is necessary in order to obtain more information to adjust required mitigation measures.

In the past most of the existing evidence of the rate and spatial distribution of land subsidence in Jakarta was based on ground-based GPS surveys, extensometers and groundwater level measurements. These data are of high quality, but have a limited spatial distribution and were often conducted on the ad-hoc basis, and at low frequency. The use of satellite imagery has significantly expanded the knowledge of terrain movement in the

region. It provided higher motion accuracy in comparison to traditional survey methods and generated information over a larger area corresponding to the satellite image (40x50km² for Cosmo SkyMed). This type of information was simply not available to the local authorities previously and allowed to identify new zones which are at risk of subsidence and which were not previously covered by in-situ techniques.

The risk information derived from satellite-information was considered of an important step to prioritize the areas where the ground water extraction is affecting critical infrastructure and to evaluate the necessary interventions (i.e. law enforcement in controlling and monitoring the stability of the buildings which are five floors and higher, measures to control ground water extraction). Such information is also of key importance when conducting flood risks assessment in the city, for example concerning the stability of the seawall constituting Jakarta coastal defence as well as for advocacy for further risk resilient spatial planning in the city which involves multiple stakeholders: port authorities, local transport agency, authorities responsible for water resources, housing and settlements. The technical capacity to use these satellite-based information products needs to be built up as well as awareness raising and investment in IT infrastructure to make sure that this risk information is put to use.

“This study provided much recent and more comprehensive and encompassing information and at higher resolution than previously available. It was suitable for use: both to update on previously available data on Jakarta's subsidence, and particularly as a means to achieve higher sense of urgency when communicating the issue to Jakarta decision makers and stakeholders. Previous information on subsidence was largely based on terrestrial sample point monitoring, and do not offer anywhere the resolution, quality or timeliness possibilities offered by this analysis. The Government is implementing a World Bank supported flood mitigation project targeted at restoring existing flood channels. The information on subsidence at local level provides the knowledge to enable a better idea of infrastructure reconfiguration needs going forward in the long-term flood mitigation efforts in Jakarta. The high-resolution analysis provides for a more compelling justification for projects and better impact when in project discussions and dialogue with the authorities and stakeholders. The timeliness and relatively quick analysis provides for the possibility to shorten the project preparation timeframe.”

Fook Chuan Eng, Senior Water and Sanitation Specialist, World Bank Jakarta Country Office.

2. Mapping of Transport Corridors in Baku, Azerbaijan (Asian Development Bank)

Background

Current transport infrastructure data availability and quality often limit the development of sustainable transport policies, investment strategies and models of future transport needs. Data gaps also constrain the ability to evaluate impacts of such policies and investments. Detailed and updated knowledge about the spatial distribution of transportation assets is relevant also to disaster risk reduction policies.

Results

To support the Asian Development Bank's interest in understanding the use of satellite-based data, ESA demonstrated the contribution that EO could make to several relevant types of bank activities: updating the inventory of transport infrastructure (mainly roads,

railroads, waterways, airports), understanding of the transport infrastructure evolution in time, identifying existing gaps, and estimating the population around points of interest.

In Baku (Azerbaijan) EO-based information supported public transportation ADB development projects both in the preliminary design and in the executive design phases, providing information supporting the planning (e.g. population distribution around railway stations) and the detailed design activities (e.g. very high-detail land use and building footprint information along a planned public transport corridor).

Two specific examples of detailed land-use mapping derived from Very High Resolution (VHR) Optical satellite data are given below in Figures 1 & 2.

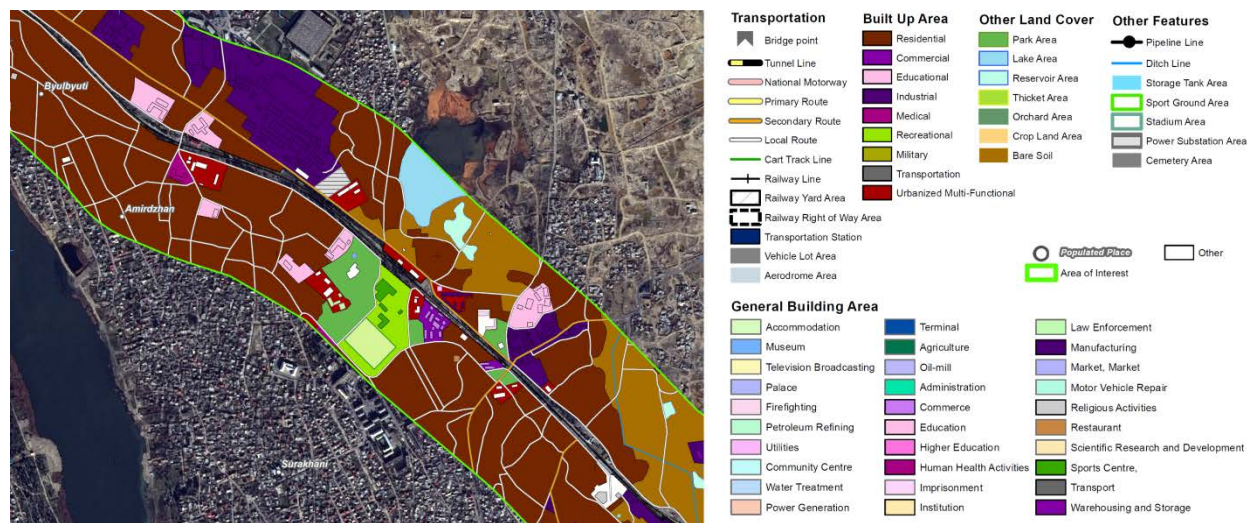


Fig. 1: Detailed land use mapping in a 500 m corridor along an existing railway line in the Surakhani area in Greater Baku. The mapping focuses on non-residential elements and is based on SPOT 7 / Azersky imagery with 1.6 m spatial resolution, acquired on 2014 December 14 (shown also as background). Not all legend items are necessarily present in the shown image. SPOT 7 data © Airbus DS. Credit: e-GEOS S.p.A. for ESA and ADB.



Fig. 2: Population estimates within a 1 km radius from Bilajari station (Baku). The estimation is done by disaggregating most recent census data with residential building blocks as identified in the land use map. The total estimated population within the area was 31875 inhabitants (average density: 10151 inhabitants/km²).

Background: SPOT 7 / Azersky acquired on 2014 December 14. SPOT 7 data © Airbus DS. Credit: e-GEOS S.p.A. for ESA and ADB.

“One of the major opportunities we had by using satellite imagery analysis is obtaining the data we needed without going into the field. Satellite imagery allowed us to scan completely the corridor where we work, and to get all the data for the utilities, for the width of the corridor. Everything present in the corridor from one facade to the other was perfectly represented in the satellite imagery. It also allowed us to analyse the land use around the mass transit stations that we are planning.”

David Margonsztern, ADB Senior Urban Development Specialist (Transport) for the Baku project.

“The benefits of using this technology for ADB is that we can plan and deliver our projects better, based on more reliable, better and more cost-effective information. For the same amount of money that we spent for planning previously, we can ask for more and better data, and deliver better services. That’s especially important for public transport planning, like for corridors of Bus Rapid Transit systems or even when looking at informal transport.”

Katja Schechtner, ADB Transport Specialist involved in the ADB Global Transport Intelligence – Transport Outlook Asia activity

3. Supporting Land Administration, Bolivia (Inter-American Development Bank)

Background

The Chaco dry forest region in the South of Bolivia and Eastern part of Paraguay is an important wilderness area. However, deforestation and land degradation due to uncontrolled expansion of soy and livestock are rampant. The region is experiencing one of the highest deforestation rates in the world. Providing policymakers at the International Financing Institutions (IFIs) and government agencies with the knowledge and tools to make better informed decisions on the basis of historical to current information habitat quality, deforestation and crop distribution and performance can help design more sustainable policies. Such information will in addition enable farmers to raise productivity and income in existing agricultural areas.

The IADB (Inter-American Development Bank) Land Administration Program II project supports setting up an environmental cadastre to address land tenure control issues resulting from uncontrolled soy and livestock expansion causing deforestation and ecosystem degradation. Improving the estimation and availability of land pricing

information and informed land allocation can help promote sustainable agricultural expansion in less vulnerable areas.

The project is being developed with partners in Bolivia, including IADB Bolivia, INRA (National Agrarian Reform Institute of Bolivia), SENASAG (National Service for Animal and Plant Health and Food Safety of Bolivia), and the Bolivian Ministry of planning and CAO (Camara Agropecuaria del Oriente – Farmer Association).

Results

EO-based mapping information services were developed to provide a baseline to estimate the impact of the land titling on the state of natural resources. A new and updated database on deforestation and land use change has been combined with existing land titling boundary data to evaluate the deforestation rate, historical trends and forecast future changes to help inform and develop suitable deforestation mitigation measures.

Coupled with information on the land transactions and pricing it was also possible to evidence that there is a negative relationship between forest covered area and parcel prices, which implies that there is an opportunity cost of the buyers to convert forest into grass or cropland, which can increase the value of the parcel in future transactions.

These insights will help support governments to fortify their assistance to small-scale farmers and strengthen land use policies using historical fact-based land cover information. It will also focus on raising awareness to influence the local to global demand of sustainably produced agricultural commodities and supply chain transparency in addition to engaging the finance sector with new opportunities for investment.

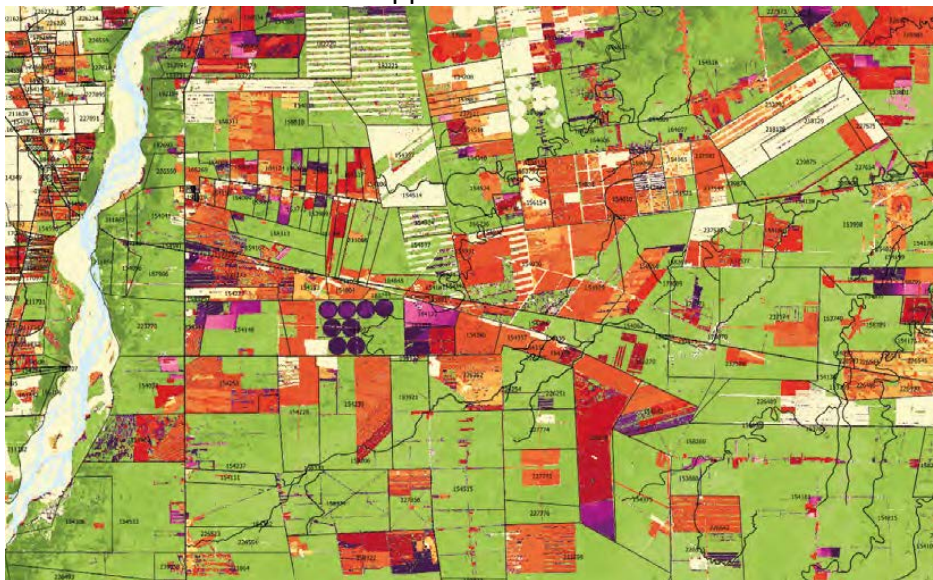


Figure 1: Deforested areas derived from time-series analysis of Sentinel-1 radar and optical Sentinel-2 and Landsat imagery. Black lines: land title database courtesy of INRA Bolivia. Example from Santa Cruz, Bolivia. Credit: EO4SD Agriculture Cluster (Satelligence for ESA/IDB, 2017).

Conclusions & Way Forward

Through this initial work, the benefits that EO can bring to Development Aid operations are beginning to emerge and can be summarised as:

- EO can **increase efficiencies in existing operations** through better use of resources (economic, manpower, time) with a globally consistent approach to implement and monitor activities,
- EO can **improve definition of future operations** through more informed development planning and methodologies,
- EO can **extend capabilities** by supporting policy formulation to allow environmental analysis in a way that is not possible by other means (eg. impact of Climate-Change).
- EO can promote **better transparency, responsibility and accountability** through the use of open data.

These experiences have also led to a better understanding of the some key issues involved in growing the use of EO in the development aid sector, which are summarized as:

- **Awareness** : better understanding what EO can deliver needs to be improved through a range of material that is specifically designed and adapted to the needs and language of the development aid community,
- **Acceptance**: the value-proposition of EO needs to be credible and punchier, and the relevance to ODA working methodologies (e.g. Monitoring & Evaluation) more apparent,
- **Adoption** : a comprehensive training programme is required to ensure that it is understood by practitioners how to use EO information easily in their operational activities. For the IFIs this includes not only bank staff, but (more importantly) the government departments in the recipient states.

Given this potential and the changes now taking place in the EO and ICT domains, an opportunity presents itself to ‘mainstream’ the use of EO-based information into international development aid projects and activities. Here, ‘mainstreaming’ is to be understood as EO-based information planned-in technically and financially as a systematic ‘best-practice’ source of environmental information for all operational phases of international development projects; ie: *Identification, Preparation, Appraisal, Negotiation*, and (most importantly) *Implementation*.

Recognising this background and previous achievements, the heads of the leading Space Agencies (through the Committee of Earth Observing Satellites : CEOS), have recently underlined their joint commitment (at the 31st CEOS Plenary, October 2017) to develop a coherent strategy and approach to promote and expand the use of EO in the domain of Development Aid, to support activities being carried out in a socially responsible and environmentally sustainable manner.