EBRD COVID-19 Resilience Framework - Environmental and Social Assessment Training Programme

Module 4 - GIS and Spatial Data Management – ESDD Guidance

Introduction

The use of Geographic Information Systems (GIS), geospatial technology and spatial data management is a powerful tool that can provide the ESDD consultant with a broad understanding of how, and where, the Project could interact with environmental and social receptors.

GIS is a system of providing a database of geospatial information layers, viewed through a digital and interactive map. The power behind GIS lies in the quality of data and analytical tools that can be used.

Geographic data can be displayed and managed using the following types of datasets:

- Raster - grids of rows and columns where each cell or pixel stores an attribute value. Examples include satellite or aerial imagery, digital elevation models, scanned topographic maps or imagery acquired from the use of drones;
- Vector - attributed points, lines, polygons, representing surface features. Examples include community locations, water wells (points), rivers, roads, railways or utilities (lines), watersheds, habitat mapping, protected areas (polygons); and
- Non-spatial data - text, tables, or field photographs that can be included based upon their location and compass direction of view.

Various GIS software platforms are available to manage spatial data. These include commercial platforms such as ESRI ArcGIS and MapInfo, and freely sourced platforms such as QGIS[1]. In addition, Google Earth also provides a useful source of satellite imagery.

The benefits of using GIS and spatial data during ESDD studies include the ability to:

- identify the type and proximity to key environmental and social receptors from Project facilities and infrastructure;
- assist in the planning of the Task 2 site visit where only specific Project locations may be visited due to time and other practical constraints;
- incorporate data gathered in the field using Geographical Positioning Systems (GPS) and mobile mapping applications, including GPS-tagged digital photos; and
- being able to present ESDD findings using GIS and illustrated maps.

The guidance on GIS and spatial data management is presented across each of the

[1] https://qgis.org/en/site/

three ESDD tasks. A glossary and list of terms used is provided at the end.

Task 1 – Review of existing documentation

During Task 1 the ESDD consultant should review the Client's GIS and add additional information that is publicly available. The GIS specialist will need to closely liaise with the ESDD environmental and social specialists during each step described below.

Defining the study area and review of data sources

It is necessary to define the study area to focus the desktop review. The study area can be defined by taking into consideration the following (amongst others):

- the Projects area of influence that is defined in the Environmental and Social Impact Assessment (ESIA);
- hydrological catchments;
- the location of associated facilities;
- sources of cumulative impacts; and
- the administrative boundary of the regions or districts the Project facilities and infrastructure are located in.

Once the study area is defined, publicly available data sources should be checked for relevant information that has not already been captured in the Client's GIS and accompanying documents. This could include:

- internet searches to gather background information, freely available datasets, maps and photographs that can be integrated into the GIS;
- checking freely available sources of satellite or aerial imagery, such as Google Earth or the Sentinel satellite missions which provide a useful basemap for analysis;
- querying recognised database sources, for example the Integrated Biodiversity Assessment Tool, that provide information on protected areas; and
- using image interpretation and data analysis tools within the GIS software to conduct an analysis of the data sets available. This could include, for example, a land use classification analysis, or an assessment to determine what changes in vegetation coverage has occurred within the same area using data sets from different periods of time.

Each source of spatial data should be evaluated for their relevancy (including when the data was collected), seasonality as some information may have been captured during a specific time of year when receptors may not be present, and the scale of their coverage to check if the information is provided at a general national level, or if it was gathered at a local scale.

A summary of useful data sources that have an interactive map search functionality is provided overleaf. This is intended as a guide and further datasets of interest and their weblinks are provided at the end of this guidance document.

Data source	Description	Website link to obtain GIS data
Open Street Map	Open access to map data available to desktop and mobile applications	https://www.openstreetmap.org
Google Earth	Google Earth available for use on the web, desktop or mobile devices	https://www.google.com/intl/en_uk/earth/versions
EarthExplorer	Free access to global satellite imagery, mapping and elevation datasets provided via the USGS	https://earthexplorer.usgs.gov
Copernicus Open Access Hub	Portal providing free access to the European Space Agency Copernicus program and Sentinel satellite missions data	https://scihub.copernicus.eu/dhus/#/home
World Resources Institute	Maps, charts, data sets, infographics, and other resources, searchable by location or topic type	https://www.wri.org/resources
Food and Agriculture Organization GeoNetwork	Access to maps, satellite imagery and related spatial databases maintained by Food and Agriculture Organization and its partners	http://www.fao.org/geonetwork/srv/en/main.home
European Union Open Data Portal	European Union Open Data Portal provides access to an expanding range of data from the European Union institutions	https://data.europa.eu/euodp/data
ArcGIS Living Atlas of the World	Global geographic information including maps, apps, and data layers in ArcGIS ready formats	https://livingatlas.arcgis.com/en
Proteus	Proteus Partners in collaboration provide access to tools and resources such as IBAT, Protected Planet, Ocean Data Viewer and Biodiversity A-Z	https://www.proteuspartners.org
Integrated Biodiversity Assessment Tool	Data and map search service for global biodiversity information	https://www.ibat-alliance.org
Protected Planet	Global terrestrial and marine protected areas and spatial data	https://www.protectedplanet.net
United Nations Educational, Scientific and Cultural Organization World Heritage List	Global natural and cultural World Heritage sites searchable by map or site name.	https://whc.unesco.org/en/list
MAB Biosphere Reserves	Man and the Biosphere Reserves searchable by country	https://en.unesco.org/biosphere/wnbr

Data source	Description	Website link to obtain GIS data
Ramsar Sites Information Service	Global database of Ramsar Wetlands searchable by map or site name	https://rsis.ramsar.org
World Database of Key Biodiversity Areas	Global Key Biodiversity Areas and Important Bird Areas and links to associated information	http://www.keybiodiversityareas.org/home
Alliance for Zero Extinction Sites	Global sites searchable by map with links to associated information	https://zeroextinction.org/site-identification/2018-global-aze-map
Ocean Data Viewer	Interactive map viewer providing access to a number of marine focused global spatial datasets	https://data.unep-wcmc.org
Natura 2000	Web viewer to visualize location of Natura 2000 sites and to access information and data	https://natura2000.eea.europa.eu
International Union for Conservation of Nature Redlist	Redlist Species database and mapping of species range extents	https://www.iucnredlist.org
Global Biodiversity Information Facility	Global Biodiversity Information Facility providing open access to biodiversity data	https://www.gbif.org
Global Forest Watch	Online platform providing data and map viewer tools for monitoring forest cover	https://www.globalforestwatch.org

Additional guidance is presented below in relation to the types of spatial data that can be used.

The use of imagery to create a basemap

The use of imagery to create a basemap is important so that other types of GIS data can be placed on top as layers. Typical sources include:

- Google Earth;
- image basemaps that are available through ESRI or another GIS software providers;
- freely available satellite imagery such as Sentinel-2 (10m resolution);
- commercially available satellite imagery that may be available from the Client or purchased; and
- Digital Elevation Models and Digital Terrain Models from free sources such as SRTM DEM[2] (30m resolution) which also provide details of topography and drainage features.

[2] http://srtm.csi.cgiar.org/

NOTE: a useful feature of Google Earth is the ability to view historical imagery for the same geographical area, which can be used to understand how environmental and social features have changed over time. This could include, for example, changes in a shoreline environment, general land use conditions, changes in forestry cover, expansion of settlements over time, and other types of trends.

Settlements and public infrastructure

Settlements and public infrastructure can also be added, using sources such as Open Street Map which contains a variety of spatial datasets and is available in GIS-ready formats with extensive coverage of many countries. Other information sources may include administrative boundaries from Global Administrative Unit Layers and population datasets from Gridded Population World.

Natural features

Natural features are included within Open Street Map data and other freely available data sources such as those from World Resources Institute or Food and Agriculture Organization GeoNetwork and may include:

- hydrological features, rivers, waterbodies, flood plains, wetlands, groundwater aquifers;
- vegetation mapping and land cover;
- ecosystems and habitat data;
- landforms and soils; and
- natural hazards.

Protected and important areas for habitats, species and ecosystem services

The presence of protected and important areas for habitats, species and ecosystem services can be added as a specific GIS layer. Boundary information can be obtained from the Integrated Biodiversity Assessment Tool or World Database of Protected Areas.

Example of protected and important areas for habitats, species and ecosystem services include:

- UNESCO World Heritage Sites;
- UNESCO Man and Biosphere Reserves;
- Ramsar Wetlands of International Importance;
- IUCN Category Areas;
- Emerald Network;
- Natura 2000;
- National Parks, Forest Reserves, etc.;
- Marine Protected Areas;
- Key Biodiversity Areas;
- Important Bird Areas;
- Alliance for Zero Extinction Sites;
- Global layers for: Endemic Bird Areas, High Biodiversity Wilderness Areas; and
- Global 200 Ecoregions.

GIS data types and storage

Boundaries of these areas is typically represented in GIS by polygons. In some cases the information on the boundary may be incomplete and instead a single point location could be provided. For a more complete analysis of a protected area, including the reason for the designation, accompanying documents will need to be identified in close liaison with the ESDD environmental and social specialists.

All of the GIS data collected should be documented noting the following:

- source (data distributor, data owner, weblink);
- accuracy (confidence in the quality and accuracy of data provided);
- validity and creation date (the information provided may be out of date or since been superseded);
- locational accuracy (positional accuracy against other spatial data layers);
- scale of use and resolution;
- metadata;
- usage constraints and copyright; and
- limitations and any gaps in the data.

GIS vector data created can be stored in various formats including a shapefile or geodatabase.

Raster data such as satellite imagery data is often stored in image formats such as GeoTIFF format for raw and full resolution data, and JP2000 for compressed and processed imagery. Raster files should include embedded data to locate the image within the Project's coordinate system, such as for GeoTIFF a TFW 'world' file, or JPG with JPW 'world' file. Data may also be supplied in other file formats, such as 'grid' or ASCII.

Illustrating GIS data

A series of GIS maps should be prepared to illustrate the Project's key features including:

- the physical footprint of the Project, including any temporary areas of land that are to be used;
- the location of any associated facilities and sources of cumulative impacts;
- the Project's area of influence as defined in the ESIA;
- existing infrastructure within the study area including roads (and their classification), pipelines, telecommunication lines, and public buildings such as schools, healthcare facilities, etc.; and
- key environmental and social receptors that have been identified through close liaison with the ESDD environmental and social specialists. These may include nearby communities, biodiversity features, water bodies, cultural heritage resources, etc.

The GIS maps should also be used to prepare for the Task 2 site visit. It may be useful to prepare a Map Book that contains printed maps at different scales covering each Project facility or location to be visited. In addition, the GIS data could be uploaded into a mobile mapping device such as a GPS enabled tablet.

Task 2 – Site visit and discussion with Client representatives

The spatial data collated as part of the desktop based review and its interpretation should be checked during the site visit. The field visit provides an opportunity to capture additional information and use photography to improve the understanding of environmental and social receptors, including land use conditions and cultural heritage sites. The season during which the field visit is undertaken should be considered, as this may not be the same time of the year when the basemap imagery was collected and is being used.

Site visits should use a variety of technology to assist the collection of data, including GPS enabled cameras, mobile devices and mobile mapping applications. Aerial surveys could also be conducted during the site visit using drones, if this is possible and that permission from any relevant authorities has been granted.

Digital photographs and other information collected in the field can often be passed to the GIS specialist without sufficient information about the location or viewing direction, making it impossible to incorporate them into the GIS. Using GPS enabled technology, such as GPS-tagged digital cameras, will ensure that all field data is captured along with information on its precise location.

There are a variety of mobile mapping applications that can be used in the field to help navigate the ESDD consultant, in using GPS enabled location technology even if the device is not connected to the internet. Mapping applications typically allow GIS data to be loaded into the device in advance so that the boundary of a future Project facility, for example, can be added as a coloured line.

Mapping applications can be used for:

- locating yourself and the boundary of nearby Project features that may not be physically marked on the ground;
- identifying and navigating to locations of interest in the field;
- viewing the compass directions on interactive maps;
- tracking routes taken in the field;
- recording verbally field notes whilst refencing your position on the map;
- recording the location of stakeholder engagement activities;
- taking field photographs that are geotagged;
- using basic map functionality such as the measurement of distances and areas; and
- exporting all collected field data into a GIS-ready format for further use.

Task 3 – Analysis and reporting using the EBRD format

The findings of Task 1 and 2 need to be integrated into EBRD's Reporting Framework which is presented in Module 3 of this training programme.

Changes made to existing data sets following the Task 2 field visit should be clearly documented and noted.

When creating output maps for reporting purposes, the majority of maps will consist of a standard layout and use of standard symbology. Maps produced should contain

the following basic map elements:

- version number and date;
- title and subtitle where required;
- grid (geographic and UTM grids as required);
- map Projection details (Projection, spheroid, datum, unit of measurement);
- logos if required;
- location diagram or sheet index diagram (where required for a series of maps);
- reference to the data layers and sources of information within the map;
- legend;
- scale bar;
- north arrow; and
- copyright © (incorporating the appropriate image source credits).

The GIS maps that need to be prepared to support ESDD findings will be requested from the relevant environmental and social specialists. Features in the maps may include:

- the Project's physical footprint, associated facilities and sources of cumulative impacts;
- environmental or social receptors including protected and other types of designated areas, as well as social data such as communities and public infrastructure; and
- image analysis including land cover classifications, the outcome of habitat mapping, details of the calculated area of a feature which is directly impacted by the Project (such as a certain percentage of a forested area being cleared for the Project).

All finalised GIS datasets should be accompanied with metadata. Metadata is an important component of managing GIS data and provides a description of the way in which the data was created. Metadata provides essential information regarding the data source, time of data capture, validity, intended scale for use, producer, copyright and license information and indications of reliability and accuracy.

Methods for metadata creation will be dependent upon the software selected for use and management of the spatial data. Metadata should include:

- Abstract: Brief summary of the dataset and its content.
- Purpose: Why the dataset was created.
- Language: Language of metadata and dataset.
- Access Constraints: Restrictions on access to the dataset.
- Use Constraints: Restriction on the use of the dataset after access.
- Dataset Credit: Copyright statement.
- Contact: Point of contact.
- Title: Filename.
- Data Collector: Person who collected the data (if applicable).
- Data Originator: Person who collated and/or processed the data (if different from collector) including their full contact details (Company name, address, telephone, email).
- Version: Version / edition of the dataset.
- Creation Date: Creation date of the dataset.

- Last Revision Date: Date of latest data revision.
- Time Period: Time period applicable to the data, including time period the data were collected and correspond to the ground.
- Projection and Datum: Name and details of Projection and datum used.

Additional guidance, tools and reference documents

Good Practices for the Collection of Biodiversity Baseline Data available at: https://www.ebrd.com/cs/Satellite?c=Content&cid=1395245538876&d=&pagename=EBRD%2FContent%2FDownloadDocument

Additional GIS and spatial data resources:

- Aquamaps - FAO's Information System on Water and Agriculture http://www.fao.org/nr/water/aquamaps/
- Birdlife International Datazone - website providing information on Important Bird Areas and protected areas http://www.birdlife.org/datazone/home
- DIVA-GIS - free geographic data for any country in the world http://www.diva-gis.org/gdata
- FAO / UNEP Land Cover Classification System http://www.glcn.org/sof_1_en.jsp
- GADM - maps and spatial data for all countries and their sub-divisions https://gadm.org/index.html
- Global Administrative Unit Layers (GAUL) http://www.fao.org/geonetwork/srv/en/metadata.show%3Fid%3D12691
- GeoCommons – open repository of data and maps for the world http://geocommons.com/
- Geofabrik – Open Street Map data extracts by country https://download.geofabrik.de
- GPW - Gridded Population of the World https://sedac.ciesin.columbia.edu/data/collection/gpw-v4
- Mangrove Forest distribution http://sedac.ciesin.columbia.edu/data/set/lulc-global-mangrove-forests-distribution-2000/data-download
- ReliefWeb - up to date humanitarian information and analysis including maps and graphics http://reliefweb.int/countries
- ThinkHazard! - web-based tool to consider the impacts of disasters on new development Projects http://thinkhazard.org/en/
- UNEP-WCMC – detailed list of available resources and spatial datasets https://www.unep-wcmc.org/resources-and-data
- WWF Ecoregions – Global 200 Ecoregions https://www.worldwildlife.org/biomes

EBRD Covid Resilience Framework - Local Environmental and Social Due Diligence Skills Capacity Building Programme

GIS and Spatial Data Management – ESDD Checklist

	Please confirm all of the actions have been completed	Yes / No
	Defining the study area and review of data sources	
1	GIS data and accompanying documentation has been requested from the Client.	
2	The GIS study area has been defined.	
3	The Projects direct footprint has been included and mapped.	
4	The Projects potential area of influence has been identified and is mapped.	
5	A suitable coordinate reference system has been identified for use.	
6	A desktop review of existing sources of spatial data has been completed and organised in a logical manner.	
7	Spatial datasets have been reviewed for accuracy, validity, seasonality, and gaps have been identified.	
8	The imagery basemap has been prepared and locations of key environmental and social features of interest have been identified in close collaboration with the environmental and social ESDD specialists.	
9	A Map Book has been prepared through liaison with the environmental and social specialists conducting the site visit.	
	Task 2 – Site visit and discussion with Client representatives	
10	A field data collection methodology has been agreed with the GIS specialist.	
11	Data obtained from the field has been checked for its accuracy and validity, and incorporated into the GIS where possible.	
	Task 3 – Analysis and reporting using the EBRD format	
12	The GIS consultant has discussed with the environmental and social ESDD specialists the maps that need to be included in the ESDD Report.	
13	A meta data file has been prepared to record all GIS information gathered, collected and incorporated into the GIS.	

Glossary and list of terms used

AOI	Area of Interest / Area of Influence	Bounding area to be used to identify extent of mapping required, focus area for an activity
ASCII	ASCII	The industry standard format for text data
AZE	Alliance for Zero Extinction Sites	Locations of important sites recognised for prevention of global extinctions, species restricted to single sites
CRS	Coordinate Reference System	The global, regional or local Project system used to locate geographical information and spatial data
DEM	Digital Elevation Model	Elevation data providing height information, often derived from satellite or aerial sources. DEM includes first return heights, i.e. includes buildings and vegetation
DTM	Digital Terrain Model	Elevation data providing height information, often derived from satellite or aerial sources. DTM includes ground return (i.e. vegetation height removed)
ESA	European Space Agency	Provider of a number of freely available satellite and satellite derived datasets
ESIA	Environmental and Social Impact Assessment	Method of analysis that identified potential implications of a proposed development on the social, biological and physical environment of the surrounding area
ESRI	Environmental Systems Research Institute	An industry supplier of GIS software and systems
GAUL	Global Administrative Unit Layers	Access to global administrative spatial data initiated by FAO and other partners
GBIF	Global Biodiversity Information Facility	Access to global scientific data on Biodiversity
GDB	Geodatabase	A GIS format for storing and managing spatial data
GeoTIFF	GeoTIFF	An image format used for mapping data, it is automatically located correctly with reference to the Project coordinate system
GIS	Geographic Information System	An integrated collection of computer software and data used to view and manage information about geographic places, analyse spatial relationships, and model spatial processes
GPS	Global Positioning System	Satellite based positioning systems used by GPS handheld devices and mobile mapping applications in the field
GPW	Gridded Population of the World	Gridded population dataset available at varying resolutions
IBA	Important Bird Area	Internationally recognised area important for the conservation of birds
IBAT	Integrated Biodiversity	Online access to data, reports and mapping on

	Assessment Tool	protected areas and biodiversity areas such as KBAs
KBA	Key Biodiversity Areas	Internationally recognised areas for the conservation of biodiversity across terrestrial, freshwater and marine ecosystems
MAB	UNESCO Man and the Biosphere Reserve	Sites of importance designated as Biosphere reserves linking social and ecological systems
OSM	Open Street Map	Open data source for country specific layers including populated places, infrastructure and natural features
QGIS	Quantum Geographic Information System	An industry supplier of freely available GIS software
SHP	Shapefile	Format for storing GIS vector datasets
SRTM	Shuttle Radar Topography Mission	Freely available elevation (DEM) datasets
UAV	Unmanned Aerial Vehicle	A small unmanned aircraft deployed with GPS camera or video technology used to obtained local scale imagery of an area or feature of interest in the field. Otherwise known as a drone.
UNEP-WCMC	UN Environment Programme World Conservation Monitoring Centre	Provider of a number of global environmental spatial datasets
UTM	Universal Transverse Mercator	Commonly used coordinate system, the relevant local UTM zone should be identified for mapping purposes
WDPA	World Database of Protected Areas	Database providing information on global protected area locations and extents
WGS84	World Geodetic System 1984	Standard datum used for mapping in both UTM and Geographic CRS, commonly used in satellite navigation including GPS.
WRI	World Resources Institute	Organisation providing access to global and country level spatial data
WWF	World Wide Fund for Nature	Organisation providing global and country level spatial data and information