DTM
IOM DISPLACEMENT TRACKING MATRIX

GEOSPATIAL SYSTEMS RESOURCE GUIDE

DOCUMENT DETAILS

Document Summary

Name	Version No.	Description
Geospatial Systems Resource Guide	1.0	This document provides overall guidance for geospatial systems, resources, and users in DTM across global, regional, and mission levels.

Revision Details

Rev #	Rev Date	Revision Description	Page No	Prev Page No	Action Taken	Addendum/ New Page	Rel Notice Ref

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ACRONYMS AND ABBREVATIONS

ESRI	Environmental Systems Research Institute
COD	Common Operational Dataset
DMA	Direct Market Access
DTM	Displacement Tracking Matrix
GIS	Geographic Information System
GSA	Geospatial Analytics
HDX	Humanitarian Data Exchange
ICT	Information and Communication Technology
IOM	International Organization for Migration
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
OSM	OpenStreetMap
UAV	Unmanned Aerial Vehicle
UN-GGIM	United Nations Committee of Experts on Global Geospatial Information Management
UNSNGI	United Nations System Network on Geospatial Information
WAF	Web Application Framework

BACKGROUND AND CONTEXT

What is GIS?

A Geographic Information System (GIS) is a system designed to capture, store, manipulate, manage, analyse, and present spatial or geographic data.[1] GIS can refer to a variety of different technologies, processes, techniques and methods.[2] While most people associate GIS with finished map visualizations, it includes the entire process of data collection, which encapsulates both geographic and non-geographic data capture; storage and manipulation using various file formats or database implementations; processing and analysis; and finally, dissemination and sharing either through web-based or static products (see Figure 1).
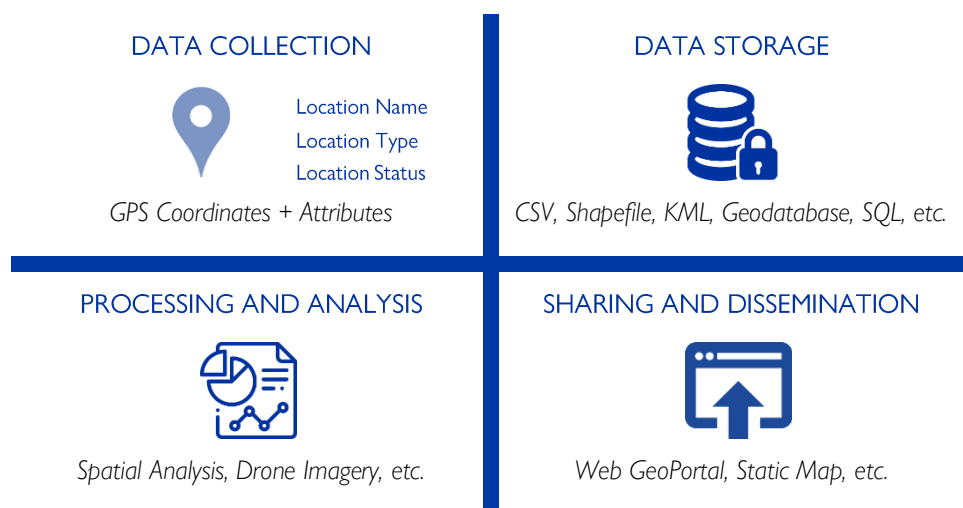

DATA COLLECTION

Location Name
Location Type
Location Status

GPS Coordinates + Attributes

DATA STORAGE

CSV, Shapefile, KML, Geodatabase, SQL, etc.

PROCESSING AND ANALYSIS

Spatial Analysis, Drone Imagery, etc.

SHARING AND DISSEMINATION

Web GeoPortal, Static Map, etc.

Figure 1. GIS Components

Why GIS in DTM?

GIS is inextricably linked to the field of migration, an entirely location-based and geographic phenomenon. For this reason, the Displacement Tracking Matrix (DTM) unit of the International Organization for Migration (IOM) is an obvious consumer of GIS systems and services to systematically collect, manage, analyze, and disseminate information on mobility patterns across the globe. GIS has a broad range of applications for DTM, including improving operational efficiency through more informed programmatic planning and implementation using geospatial analytics. This is most evident in humanitarian responses in which accurate, reliable, and up-to-date data on displacement dynamics has lifesaving consequences. And for external donors and partners, GIS often helps display key results and indicators on easy-to-read map products. Much like other humanitarian actors, UN agencies and intergovernmental organizations, GIS plays a pivotal role in DTM's operational efficiency, humanitarian response, and results-based reporting, among other areas of the unit's work. In total, GIS helps to bolster the unit's commitment to provide a better understanding of the movements and evolving needs of displaced populations, whether on site or en route.

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[1] Clarke, K. C., 1986. Advances in geographic information systems, computers, environment and urban systems, Vol. 10, pp. 175–184.

[2] Maliene V, Grigonis V, Palevičius V, Griffiths S (2011). "Geographic information system: Old principles with new capabilities". Urban Design International. pp. 1–6. doi:10.1057/udi.2010.25.

History of GIS in DTM

Prior to 2014, DTM used GIS in primarily *ad hoc* implementations without a standardized structure for GIS technicians or program managers. Geospatial products were produced through technologies acquired at the mission or project level with little coordination between operational unites for data or resource sharing. In 2014, DTM initiated an agreement between IOM and Environmental Systems Research Institute (ESRI) for provision of GIS software, maintenance, consulting services and training. With an official visit from ESRI representatives in IOM Geneva, the two organizations formalized their collaboration to adhere to the general UN Agreement in line with other UN Agencies and Programs. This represented a signification milestone for the unit as DTM users could begin to leverage ESRI products and services in a harmonized and structured approach.

Figure 2. ESRI co-founder and President Jack Dangermond (center, back) celebrates the ESRI-DTM joint partnership with other ESRI colleagues and DTM staff, including DTM Global Coordinator Nuno Nunes (left, front).

Purpose and Scope

Since the formal partnership with ESRI was initiated in 2014, the *de facto* global focal point between DTM and ESRI has been the DTM Geospatial Analytics (GSA) Team in Geneva. While the GSA Team continues to leverage this unique partnership at the global level, there is an increasing demand to adopt geospatial solutions as DTM programs expand both in terms of geographic coverage and thematic focus. For this reason, there is now a need to provide guidance to all DTM team members on the availability and accessibility of geospatial systems to better consolidate knowledge and resource management. Therefore, this document is designed to provide a one-stop-shop manual for any interested or engaged user in geospatial technologies to answer the following questions:

1) How do DTM team members leverage GIS in their work?

2) What GIS technical tools, resources, and innovations are available to DTM team members?

3) How may I leverage GIS in my work and what is expected of me when consuming GIS tools?

4) What other external partnerships does DTM engage in relation to GIS?

USER MAPPING: WHO USES GIS?

As the *de facto* liaison between ESRI and DTM at the global level, the GSA Team serves as administrator, manager, and capacity builder for DTM team members worldwide. The GSA Team works in coordination with Information and Communication Technology (ICT) colleagues, who support on software procurement and hardware deployment, to manage software licensing and supports DTM GIS users globally on technical support and capacity building. In addition to administering and managing GIS resources globally, the GSA Team actively produce various information products for DTM, manage the global reference geodatabases, and develop standard operating procedures and guidelines, among other duties (see Annex 1). While individual missions and projects may leverage GIS for their operational needs, and even enter into bilateral agreements with ESRI or other third-party vendors, the global focal point for geospatial systems in DTM continues to be the GSA Team.

Thematic Use Cases

Because of its universal application, nearly every DTM unit incorporates GIS into their work. This can range from simple cartographic products showcasing recent DTM results for an external report, more detailed multi-sectoral analysis incorporating DTM and external data sources, or even more advanced spatial analysis such as remote sensing or elevation modeling for operational purposes. The following is a non-exhaustive list of use cases of GIS in DTM.

Use Case	Description
Descriptive Analysis	**Static:** cartographic product showcasing DTM results embedded in report or standalone **Dynamic:** Web-based interactive map or application showcasing DTM results
Explanatory Analysis	Static or dynamic product layering DTM data with external sources to present multi-sectoral analysis including service area mapping, suitability analysis, or network routing
Data Maintenance	Maintain, curate, and update referential geodata (e.g. administrative boundaries)
Operational Support	Remote sensing and imagery analysis in rapid onset emergencies for situational awareness and coordinated response 3D terrain modeling to inform site planning and boundary delineation

Geographic Structure

With more than 5,000 data collectors and over 300 technical experts serving in over 90 countries, the presence of DTM worldwide is immense with a large pool of potential GIS users. Within any DTM unit, geospatial tasks can be conducted by dedicated GIS technicians (those who are explicitly tasked and use GIS in their work) or can be shared based on team composition. In cases where a DTM unit does not possess GIS capacity, geospatial service requests can be sent to regional or global offices. Conversely, GIS Technicians are often deployed from global, regional, or other country offices to support specific emergencies or longer-term capacity building initiatives.
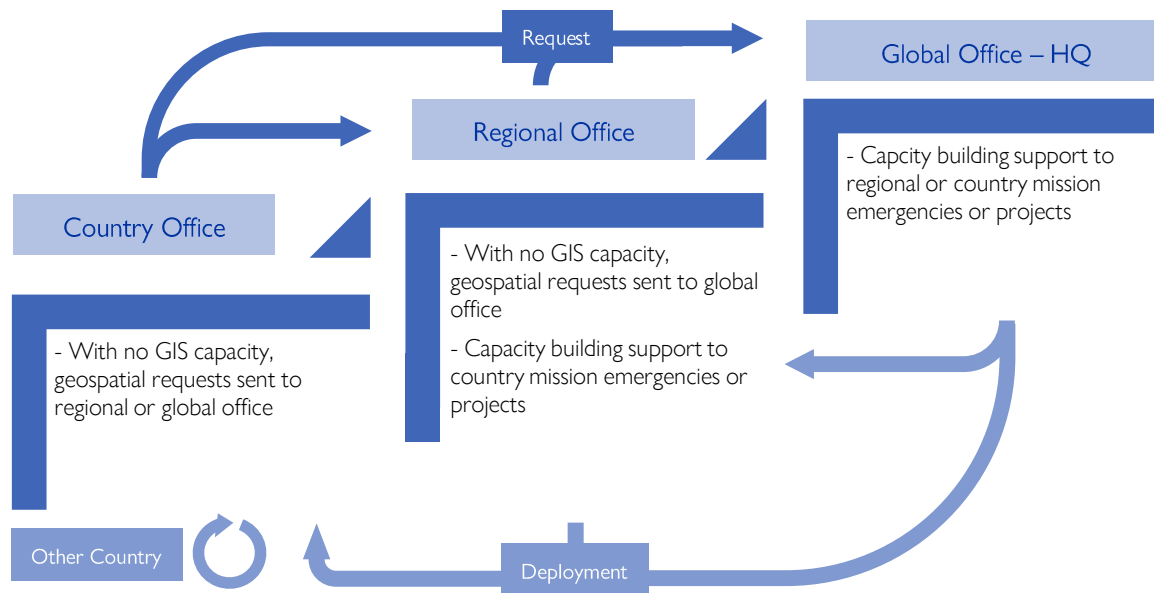
Request

Global Office – HQ

Regional Office

- Capcity building support to regional or country mission emergencies or projects

Country Office

- With no GIS capacity, geospatial requests sent to global office
- Capacity building support to country mission emergencies or projects

- With no GIS capacity, geospatial requests sent to regional or global office

Other Country

Deployment

Figure 4. Organizational chart of GIS users in DTM at country, regional, and global levels.

RESOURCES: WHAT GIS TOOLS AVAILABLE?

Tools

With a cooperative agreement established with ESRI, geospatial technicians primarily use ESRI products to complete their regular day-to-day GIS tasks. However, ESRI products are not always appropriate for a given task, due to technical or financial constraints, so DTM adopts a flexible approach to resource adoption and implementation. As such, while there is a broad range of ESRI products available to users, there is also a substantial list of open-source or third-party applications equally available. The following tables highlights most of these resources in an essential list of GIS tools available to DTM team members worldwide based on technical components.

Data Collection

Tool	Description		Advantages and Limitations	Skill Level
KoBo Toolbox	Open source suite of mobile data collection tools developed for humanitarian actors	+	- Collect geographic (GPS coordinates) and non-geographic data with custom forms - Export to various GIS-friendly file formats (CSV, KML, ZIP)	●●●●○
		-	- Not integrated with ESRI suite of tools reducing interoperability between ESRI products	
ArcGIS Online Data Collection Apps	Suite of mobile and online-based data collection tools including: Collector for ArcGIS, Survey123 for ArcGIS, and Crowdsource App	+	- Collect geographic (GPS coordinates) and non-geographic data with custom forms - Fully integrated with ESRI suite of tools for easy interoperability	●●●○○
		-	- Form customization and interoperability with other non-ESRI solutions is limited - More substantial estimated financial commitment	
SWMaps	A free Android-based GIS app for collecting, presenting and sharing geographic information. First used by DTM NPM in Bangladesh	+	- Collect geographic (GPS coordinates) and non-geographic data - Use Google Maps, OpenStreetMap (OSM), or custom mbtile and KML overlays - Export features as shapefile or KMZ file types	●●○○○
		-	- Form customization and interoperability with other non-ESRI solutions is limited - Only available on Android devices	

Data Storage

Tool	Description		Advantages and Limitations	Skill Level
Database Administrator Tools	Various applications to configure, manage, and administer server databases. Microsoft SQL Server Management Studio is most commonly used in DTM with other open-source solutions available.	+	- Easily manage geographic and non-geographic data in structured database - Dynamically update and load data into tables and create views to manipulate how GIS data is displayed - Connect directly to database server in GIS desktop applications	●●●●○
		-	- Database server required for implementation	
ArcGIS Server	ESRI core server used for creating and managing GIS web services, applications, and data. DTM maintains	+	- Publish web service feature layers or maps for further analysis and visualization online - Interoperability with ESRI suite of tools and other non-ESRI web development frameworks	●●●●●

| | global ArcGIS server(s) and country servers based on operational need. | - | - More substantial estimated financial commitment | |

Processing and Analysis

Tool	Description		Advantages and Limitations	Skill Level
ArcGIS Desktop	Collection of desktop applications to manipulate, analyse, visualize, and share geospatial content including: ArcMap, ArcPro, ArcCatalog, ArcGlobe, ArcScene, and ArcEarth	+	- Work with various GIS file formats and create geodatabases - Manipulate and query GIS data using SQL language - Perform spatial analysis using geoprocessing tools and custom scripts - Generate cartographic products with various symbology and visualization customizations	●●●●●
		-	- More substantial estimated financial commitment	
QGIS	Free open-source application to manipulate, analyse, visualize, and share geospatial content	+	- Work with various GIS file formats and create geodatabases - Manipulate and query GIS data using SQL language - Perform spatial analysis using geoprocessing tools and custom scripts - Generate cartographic products with various symbology and visualization customizations	●●●●○
		-	- Not integrated with ESRI suite of tools reducing interoperability between ESRI products	
Google Earth Pro	Free desktop application to quickly create and visualize GIS data with Google imagery services	+	- Import and export GIS data in KML/KMZ file format - Harness Google Earth imagery library including historic datasets	●●○○○
		-	- Not integrated with ESRI suite of tools reducing interoperability between ESRI products	

Sharing and Dissemination

Tool	Description		Advantages and Limitations	Skill Level
Portal for ArcGIS*	An Enterprise online platform which allows users to view, analyse, visualize, and share geospatial content. DTM maintains global portal(s) for external and internal networks.	+	- Access content from hosted service layers and the ArcGIS Living Atlas of the World - Different user types can view, manage, create, or publish geospatial content - Generate web maps and applications using predefined templates without custom coding needed	●●●●○
		-	- More substantial estimated financial commitment	
Web Application Framework (WAF)*	A software framework to provide a standard way to build and deploy web-based applications, services, resources, and APIs. DTM has implemented custom solutions including Drupal,	+	- Integrate RESTful APIs into code to query hosted service layers for dynamic visualizations - Display static hosted service layers as tile or image - Embed other applications or visualizations with IFrame	●●●●●
		-	- Not integrated with ESRI suite of tools reducing interoperability between ESRI products	

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	ASP.NET, and Javascript libraries.		- More substantial estimated financial commitment for proprietary solutions	
Business Intelligence Software	A type of visualization software designed to retrieve, analyse, transform, and report data. PowerBI and Tableau are most commonly used in DTM. PowerBI offers a plugin for ArcGIS Maps.	+	- Easily manipulate and visualize array of geospatial and non-geospatial data from a variety of sources including static files (e.g. Excel, CSV, etc.), databases (e.g. SQL, MySQL, etc.), online services, and others. - Publish custom dynamic visualizations as dashboards for public dissemination.	● ● ● ○ ○
		-	- More substantial estimated financial commitment for proprietary solutions (especially Pro versions, etc.) - ArcGIS Maps for PowerBI does not support public sharing.	

***Implementation Note:** Web application templates offered in Portal for ArcGIS can be deployed with little to no customized code, making this an ideal solution for emergency response or other time-sensitive operations. Developing a custom solution using a WAF involves more labor and time resources, making this more ideal for long-term or more customized implementations.*

DTM GIS SharePoint

DTM maintains an internal GIS knowledge and resource sharing platform accessible to all GIS users worldwide. Powered by Microsoft SharePoint and ArcGIS Server, the platform hosts a catalog of GIS referential data, internal guidance, useful resources and links, external capacity building initiatives, and a community of practice for users. More specifically, the platform includes the following elements:

1. GIS Referential Data

2. Internal Guidance

3. Useful Links & Resources

4. Capacity Building Initiatives

5. Community of Practice

Users can request access to the DTM GIS internal platform by contacting the GSA Team (DTMGIS@iom.int).

Innovations

DTM is in constant search of new and innovative technologies that improve and broaden its current geospatial systems and processes. This includes more adaptive and real-time imagery capture through use of unmanned aerial vehicles (UAV) technology, artificial intelligence platforms for geographical object detection, and machine learning initiatives for imagery processing. Moreover, DTM explores available open-source solutions which meet the requisite technical specifications to continue its mandate while simultaneously reducing operating costs. And in cases when technical or financial capacity is limited to seek alternative geospatial technologies or tools, it often forms partnerships with external organizations who can leverage DTM's breadth and experience in the field of displacement for an innovative technical solution.

ROLES & RESPONSIBILITIES: HOW TO ACCESS?

For licensed GIS tools, and specifically ESRI products, DTM maintains a global partnership with ESRI administered through the GSA Team in Geneva. Other licensed products which may not enjoy a formal partnership at present can still be procured for DTM team members worldwide in consultation with the GSA Team if needed. Additionally, open-source solutions can be acquired by individual users and the GSA Team can provide advice and support as needed. Therefore, as the *de facto* manager and administrator of ESRI products at global level and liaison with other organizations offering proprietary technologies, the GSA Team remains the global focal point for geospatial tool licensing.

Due to the formal partnership with ESRI, the following procedures apply to ESRI products available to DTM team members.

What are the available licensed products?
DTM maintains a pool of ESRI licenses in Geneva for all global, regional, and mission users. The following is a comprehensive list of licensed tools available:

ArcGIS Desktop Standard (more info: Overview | License Levels)

ArcGIS Desktop Extensions (more info: Overview):
3D Analyst
Data Interoperability
Geostatistical Analyst
Network Analyst
Publisher
Schematics
Spatial Analyst
Tracking Analyst

ArcGIS Enterprise

Portal for ArcGIS
-ArcGIS Online Creator Subscription (more info: User Types) with access to IOM Geoportal

ArcGIS Server
-Publish services on DTM Internal and External servers for further dissemination in web-based products
-Deploy dedicated server for mission or project-specific needs (case-specific with proper coordination with GSA Team and relevant ICT colleagues)

How to acquire licensed products?
To request a product or license, users are asked to submit the GIS License Request form and will be contacted by the GSA Team upon submission regarding the status of the request.

If a request is successfully authorized, the GSA Team will proceed with license or credential disbursement. Please note, there is a fixed amount of licenses and products available meaning **requests may be denied if all available licenses or products are currently borrowed.**

Users are also able to purchase licenses **directly** from ESRI or other third-party developers should the current product offering be insufficient for project or program needs or other considerations. While the GSA Team can help liaise with

ESRI and relevant ICT colleagues, the **responsibility rests with the initiating office for license procurement and maintenance**.

What resources are needed to acquire licensed products?

The pool of available licensed products is updated every year through maintenance licensing fees. This ensures the current product offering meets the needs of DTM operations and can be adapted to include the most up-to-date features and tools offered by ESRI. For this reason, the annual fee may fluctuate in addition to the number of total users from year to year.

Users utilizing a product in the current list of pooled licenses are requested to contribute to the annual maintenance licensing fee. However, a standard quotation for product license usage is difficult to estimate as the annual fee and number of users varies each year. **Therefore, it is recommended to consult with GSA Team to estimate expected financial requirements for license usage.**

Thanks to the global partnership with ESRI, DTM and IOM operations in general benefit from Direct Market Access (DMA) pricing from ESRI used for all UN agencies and related programs. For offices which wish to procure **licenses directly from ESRI, discounted rates up to 45% are available** through this [DMA agreement](#).

What are the expectations of end-users of licensed products?

General Terms of Compliance

In addition to the [ESRI product-specific terms of use](#), users are expected to use the licensed product(s) for the purpose as specified in the original request and as outlined in the [ICT Confidentiality and Conflict of Interest Agreement](#). If the duration of use as specified in the original requested needs to be extended, **users are requested to resubmit a GIS License Request at least two weeks prior to expiry**.

Portal for ArcGIS Terms of Compliance

Portal for ArcGIS users are asked to comply to the following additional terms:

– Users are requested to contact the GSA Team (DTMGIS@iom.int) to share any public content on the Portal. Each request should include the:

1. Specific content (e.g. Web Map, Web Application, etc.) to be shared;

2. Reasoning for public dissemination (i.e. project background);

3. Expected duration of public access.

– Users are encouraged to regularly maintain and archive their Portal content. Any user who has not been active in the Portal for more than six months will have his/her account disactivated and content archived. GSA Team members will periodically check Portal contents to ensure compliance.

DTM maintains technical partnerships with private sector and NGO actors in the field of GIS which aim to broaden and deepen the breadth of geospatial expertise within the unit. These partnerships not only benefit the organizational capacity of DTM, but also help deliver its mandate to beneficiaries and donors. Additionally, DTM coordinates with other UN agencies to ensure coherency in relation to humanitarian action and overall geospatial systems and processes across the entire UN network.

Coordination Mechanisms
Common Operational Dataset (COD)
In coordination with OCHA, DTM contributes to the creation, standardization, and dissemination of Common Operational Datasets (CODs), the authoritative reference datasets needed to support operations and decision-making for all actors in a humanitarian response. The most essential dataset for geospatial analysis used in humanitarian response are administrative boundaries, which are preferably sourced from official government sources[3]. DTM partners with OCHA and other UN agencies to develop and maintain CODs which are subsequently endorsed and published on the Humanitarian Data Exchange (HDX) for use by all humanitarian actors.

United Nations System Network on Geospatial Information (UNSNGI)
On behalf of IOM more generally, DTM is an active contributor to the United Nations System Network on Geospatial Information (UNSNGI), which was initiated in August 2017 by the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) to strengthen coordination, collaboration and sharing mechanisms on geospatial information within the UN system. Through bi-monthly coordination meetings, DTM engages in member presentations and discussions. Though a relatively nascent coordination mechanism within the UN system, DTM plans to continue its active involvement with the UNSNGI.

Global IMWG GIS Sub-Group
DTM regularly attends this IMWG Sub-Group which aims to bring together GIS specialist from different organizations into one technical work group. The goal is to improve the coordination of geospatial matters among humanitarian actors by pooling knowledge and by building on and improving existing intra-agency processes, tools and data. Another objective is to invite all partners (traditional and non-traditional) to further share and disseminate best practices, general technology and lessons learned. Tasks the group will work on must be beneficial to the whole humanitarian community and agreed upon by the group.

Technical Partnerships
ESRI
Apart from consuming ESRI products and services through a formal agreement between both organizations, DTM partners with ESRI on other technical initiatives and regularly attends ESRI-sponsored events. These include the annual GIS for a Sustainable World Conference and informal GIS Solution Meetups hosted in Geneva to drive peer collaboration and develop solutions to tackle global issues from poverty to climate change and migration. DTM aims to move beyond the typical client-service provider roles when engaging with ESRI and other third-party providers to foster a symbiotic relationship with synergistic results.

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[3] https://en.wikipedia.org/wiki/Common_Operational_Datasets

Purpose – Main duties and responsibilities

The Geospatial Analytics (GSA) Team in HQ Geneva is tasked with collecting, managing, analysing, and visualizing all geospatial information related to DTM/IOM operations at a global, regional, and mission level. These include the following tasks:

Product Development
- Visualize and map data while assuring data consistency utilizing appropriate geographic information system (GIS) tools and products.
    - Support creation of static outputs (e.g. country atlases, basemaps, thematic maps, etc.) to support DTM/IOM global, regional, and mission operations.
    - Support creation and maintenance of dynamic outputs (e.g. geoportals, web maps, data visualizations, etc.) to support DTM/IOM global, regional, and mission operations.
- Collate geographic data and administrative divisions for various DTM/IOM databases for tracking population movements and displacement locations.
- Implement GIS tools and algorithms (model builder) to facilitate geospatial analysis and enable more efficient data processing.
- Advise on the best suitable tools and methods for preparation and presentation of any analysis and results stemming from emergency assessments (CCCM, DTM and other).
- Implement geospatial analysis methodologies applying Remote Sensing software to facilitate satellite imagery analysis.
- Operate unmanned aerial vehicle (UAV) systems and perform image processing and analysis and develop UAV methodology/strategy for implementation and application in DTM/IOM emergency operations.

Data Infrastructure & Management
- Assist global IOM operations by contributing to the design, development, and maintenance of relevant spatial data infrastructure and geodatabases to ensure the effective use of the geographic information systems.
    - Work closely with the database management team to coordinate design and maintenance of the central data warehouse (CDW) to ensure smooth dataflow to geoportals, databases, applications, and other GIS solutions.
- Ensure the common spatial data standards and structures are applied and data are managed properly throughout the data management cycle, including through support in the data collection processes, query, analysis and the overall data management activities.

Standard Operating Procedures
- Prepare standard operating procedures (SOPs) on spatial data infrastructure, geodatabases, and geoportals to ensure sustainability.
- Develop and enforce design guidelines, standards, and templates for all GIS-related products.

GIS Development & Strategic Partnerships
- Continually enhance information management tools at the global level by supporting the collection, management, storage and sharing of knowledge and data.

       a.   Support the design and content management of external sharing platforms (i.e. DTM global website).
–   Strengthen links with external strategic partners and explore possibilities for expanded collaboration.
–   Coordinate with external technical partners to maintain licensing and administrative requirements of all software packages and data infrastructure.
–   Promote humanitarian use and applicability of GIS & UAV and other technical solutions with different audiences, including donors, technical experts and partner agencies.

Key expected results:
–   IOM Global Support
    o   Regularly maintain Countertrafficking and Missing Migrants Project geoportals
    o   Produce maps/visualizations for various IOM HQ departments and initiatives
–   DTM Global Support
    o   Maintain Global DTM Implementation and TDYs Tracking geoportals (internal use only)
    o   Consolidate and export geospatial content for use in DTM global website
–   DTM Regional Support
    o   Develop and maintain various geoportals at regional level (e.g. Migration Flows to Europe, Central America, etc.)
    o   Produce various maps/visualizations for DTM regional operations (e.g. monthly Mediterranean & Europe Flow Compilation Reports, EUTF-IOM Initiative for Migrant Protection and Reintegration of Returnees, etc.)
–   DTM Mission Support
    o   Develop and maintain various geoportals at mission level (e.g. Village Assessment Survey (VAS) South Sudan, Libya, Chad, Nigeria, and Iraq)
    o   Produce various maps/visualizations for DTM country operations (i.e. setup, emergency response, etc.)

Composition of the unit

The DTM GSA Team consists of four IM/GIS Officers and one GIS Support Intern. The Team will work in close collaboration with DTM colleagues in HQ, ROs, country missions and other relevant DOE units and other IOM departments.

Contact persons	Mailing lists administered
Sebastian Ancavil – sancavil@iom.int Mohamed Bakr – mbakr@iom.int Harley Emery – hemery@iom.int Adriana Yepes – ayepes@iom.int	DTM GIS Team – DTMGIS@iom.int