

DRAFT Methodology for Remote Sensing and GIS Analysis for Multiple Indicator Rapid Need Assessment (MIRA)

Context and background/Introduction:

The Multi-sector Initial Rapid Assessment (MIRA) is the first step of the Assessment and Monitoring Framework and is designed to identify strategic humanitarian priorities after the onset of natural disasters or complex emergencies:

- Within 72 hours, a situation overview based on primarily secondary data and other sources
- Within 7 days carry-out a field assessment on community level to identify needs and priorities of the affected and vulnerable population.

The remote sensing techniques and spatial analysis will be the main information sources during first 72 hours, after the onset of any disaster. Use of satellite remote sensing proved to be very useful globally for assessing the extent and impact of the disasters particularly during floods, cyclones, forest fire and crop damage. The use of remote sensing serves two main objectives:

- Securing timely information on the extent of disaster and affected population is vital to planning an initial humanitarian response and optimally allocating available resources.
- The findings will constitute the sampling frame for a field level initial needs data collection.

What is Remote Sensing?

Remote sensing is the acquisition of information about an object or phenomenon, without making physical contact with the object.

- Remote sensing makes it possible to collect data on dangerous or inaccessible areas without going there physically.
- It can replace costly and slow data collection on the ground, particularly during a humanitarian emergency when the timely information is vital for planning life saving interventions.

By satellite, aircraft, spacecraft, buoy, ship, and helicopter images, data is created to analyze and compare things like damage extent, accessibility, affected population, vegetation, infrastructure, weather, land use and others. These things can be mapped, imaged, tracked, observed and analyzed in correlation with proximity.

Composition of GIS/RS working group:

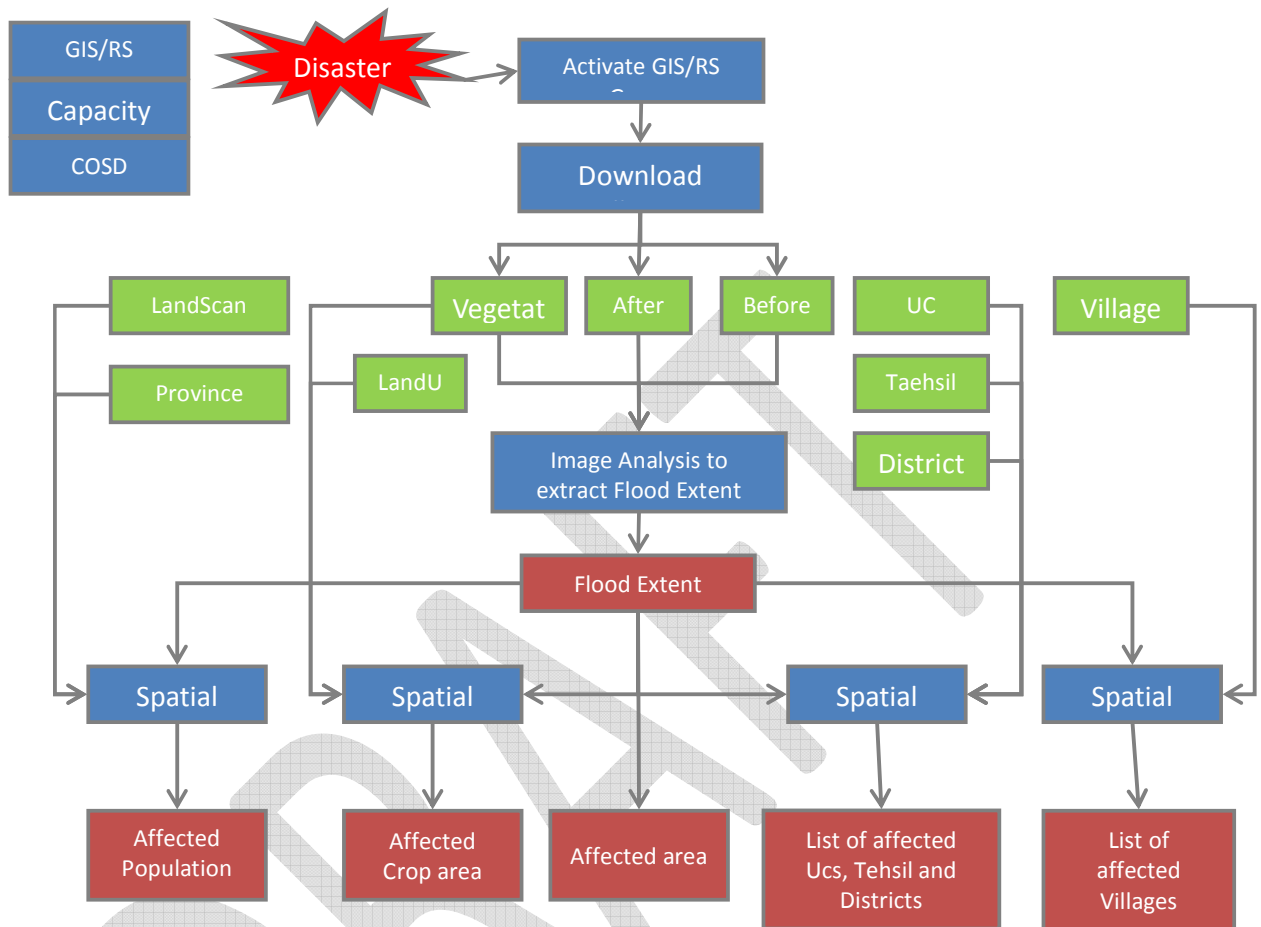
Under the supervision of a group leader, The GIS/RS working group will comprise of professionals in the field of GIS and satellite remote sensing. A team of 3-4 professionals with diversified knowledge is recommended: Fawad, WFP/VAM; Imran, OCHA; Mehwish Irfan, IOM; UN Habitat or UNDP ?

Reporting and Data sharing:

The GIS/RS group will report the results to MIRA process manager to be used for the initial response planning as well as MIRA process of primary data collection.

Process flow of Remote Sensing Analysis for MIRA:

Process flow diagram below summarizes the whole process of assessment, using satellite remote sensing and spatial analysis, during first 24-48 hours after the onset of a disaster and activation of GIS/RS group;



From the process diagram above, the process of satellite based geospatial analysis can be categorized in two major steps i.e. Pre Disaster and Post disaster activities as explained below.

Pre Disaster Steps:

Formulation of GIS/RS group: A GIS/RS group needs to be formulated to pool available technical human resources, in the country, to perform satellite based analysis, to provide information to the humanitarian agencies, within first 24-48 hours after the onset of a disaster. The group will consist of technical professionals in the field of Remote sensing, Satellite data analysis and GIS, from different UN Agencies and government to start working on spatial analysis according to standard operating procedures. National universities offering degree courses in the field of remote sensing and GIS can also bring on board for further research.

Capacity Building of GIS/RS group: Capacity building trainings/workshops of GIS/RS group will be organized to ensure a common understanding of all the group members towards the tools and techniques used and the process followed for the satellite based assessment during emergency phase of initial 72 hours and after. UNOSAT can be requested to support the capacity building process. It is also needed to ensure that the group has valid GIS and Image analysis software along with the computers capable enough to analyze the satellite data and run the relevant software. Some of the common GIS and Remote sensing software are listed hereunder.

- ArcGIS Desktop
- ArcGIS Spatial Analyst and Image Analyst extensions
- ERDAS Imagine
- ER Mapper
- ENVI

Updated Common Operational (Spatial) Datasets (CODs): the group, in collaboration with the existing IM/GIS group, will ensure the availability and access of updated common operational spatial data sets, all the time to be used during any disaster. These datasets will include.

- Province boundary (*Polygon*)
- Division boundary (*Polygon*)
- District boundary (*Polygon*)
- Tehsil/Taluka boundary (*Polygon*)
- Union council boundary (*Polygon*)
- Locations of villages (*Points*)
- Road network (*line*)
- River Network (*line*)
- Canal Network (*line*)
- Bridges (*point*)
- Digital Elevation Model (30m grid)
- Population data (pre-agreed projected 1998 Census data)
- LandScan Population grid (1km grid)
- Landuse data
- Any other relevant data

The CODs can be stored in a Geo-database in standardized relational feature classes and access can be ensured through Dropbox and shared DVDs. The Drop box is set-up and all group members can request access. Send email to khan67@un.org

- The geo-database will kept updated and shared with all the relevant stakeholders on a regular interval to ensure all the relevant professionals have access to the updated spatial data.
- Dropbox can be used to store and share non-public data between the group members.

Post Disaster Steps:

Activation of GIS/RS group: After the onset of a disaster MIRA Process Manager will activate the GIS/RS group. It would be preferred if the group can work in same location at least during first 72 hours.

Data acquisition and compilation:

1. Latest satellite data and data products from MODIS sensor of Aqua and/or Terra satellites will be downloaded at a spatial resolution of 250m. <http://modis.gsfc.nasa.gov/>
2. High resolution data can be requested through UNOSAT (who will activate the international space charter if necessary).
 - a. Contact: UNOSAT's 24/7 hotline at +41 76 487 4998, emergencymapping@unosat.org
 - b. <http://www.disasterscharter.org>

- Updated common operational spatial datasets will be shared among the group to ensure the use of same source data. Please note MODIS daily satellite images (from both aqua and Terra Satellites) and their products can be downloaded free of cost from MODIS website. Also the satellite data sets are very heavy in size and might require special arrangements for ensuring internet connectivity and speed.

Table below provides a list of available free satellite images and satellite data products along with their important parameters:

Satellite Image/ Products	Repeat Cycle	Spatial Resolution	Type	Analysis Level	Comments
MODIS/Aqua	Daily	250m	Satellite Image	National, Provincial	
MODIS/Terra	Daily	250m	Satellite Image	National, Provincial	
LandSat	16 days	15m Pan 30m multispectral	Satellite Image	District, Tehsil/taluka Level	SLC off after 2003 and gives a line drop.
MODIS Terra NDVI/EVI	16 days	250m	Product	National, Provincial	
MODIS Aqua NDVI/EVI	16 days	250m	Product	National, Provincial	

Calculating Flood Extent:

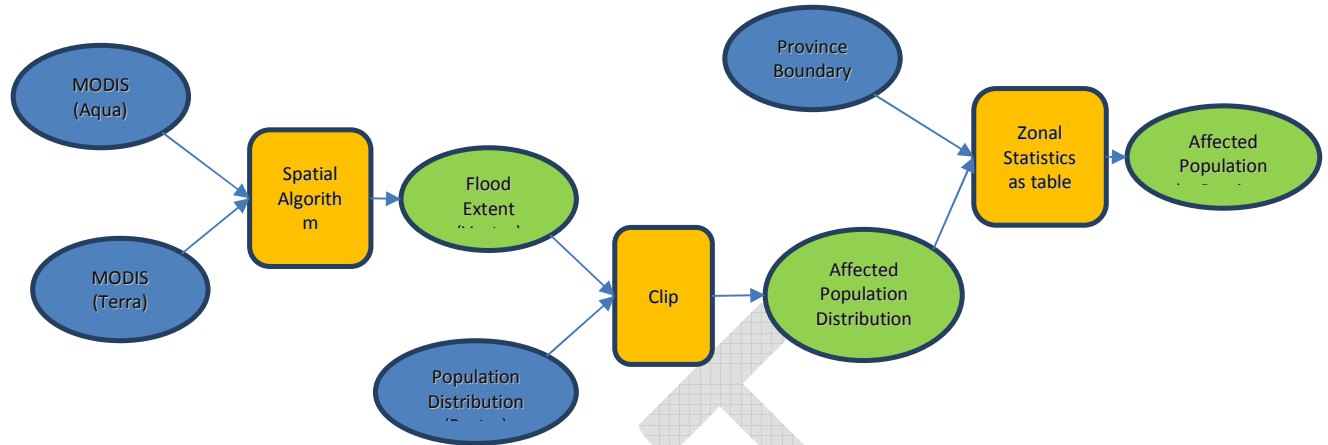
- MODIS (Aqua/Terra) provide daily satellite imageries at 250m spatial resolution, the estimates using MODIS data are only representative at national and provincial level but the major advantage is that it can be effectively used for daily monitoring during an evolving disaster like floods at no additional cost.
- Higher resolution satellite data is needed to perform analysis representative at District, Tehsil/Taluka or UC level which can be acquired through International Space Charter or UNOSAT if available, or can also be purchased if really necessary. However, because of high cost involved, it is not viable to use high resolution imagery to track the phenomenon on daily basis.
- Cloud cover can be an issue while using passive sensing particularly during monsoon season. Active sensing techniques like Radar can be used.
 - Special skill set is required to interpret radar imageries. UNOSAT to be requested to provide service, and if possible, help in developing in country hardware, software and technical skills and/or providing support from the distance on this.

Spatial Analysis and outputs: Once the flood extent is calculated, it can be spatially analysed together with common operations spatial datasets to get the following outputs;

- Output 1. Affected Population Estimates:** Flood-affected population in near real time scenarios will be assessed and will give almost a daily update of the population living in flooded areas through the use of available spatial datasets particularly daily flood extent, LandScan Population distribution grid and administrative boundaries at the provincial level.
- Weather permitting; MODIS data from Aqua and/or Terra will be interpreted on a daily basis to obtain the geographic extent of the flooding. More

detailed data (affected population on Tehsil level) can be obtained using higher resolution imageries for defined areas.

- Superimpose flood extent onto a population distribution grid to determine the number of people living within flooded area.



Output 2. Flooded Area Estimation: Flood extent will give flooded area estimation in terms of absolute number as well as in percentages for admin level 0 and 1.

Output 3. List of affected Union Councils (UCs)/Tehsils and Districts: By combining flood extent layer with various admin boundaries layers, including Union Councils (UCs), Tehsil/Taluka and districts, list of affected UCs/Tehsil/Districts can be computed.

Output 4. List of affected Villages: By combining flood extent with village locations layer, list of affected villages will be computed. This list can also be used to draw samples for the MIRA field assessment phase.

Output 5. Affected vegetative area estimates: Through spatially analyzing Vegetation indices data together with land use data and flood extent, affected vegetative area will be calculated.

Output 6. Damage to Roads and Bridges: High resolution data would be necessary which can be obtained/made available through International Space Charter or UNOSAT.

- Flood extent can be calculated using the model as explained above;
- Intersect with the road network and bridges to estimate the damages.
- Depending upon the source satellite data, the analysis can report on length of roads inundated, broken or washed away bridges and culverts.

Known Issues:

- Cloud free satellite data is needed for the extraction of flood extent. If there is heavy cloud cover for several days during monsoon season, flood extent cannot be calculated and hence all the dependant analysis cannot be performed.
 - Radar images or aerial surveys might be needed in such situation. UNOSAT can help in supporting with radar analysis or building in country technical capacities.
- It is useful in situations where water remains in place for 24 hours or more so as to be easily detected.
 - During flash floods in high slope areas, water might have already receded before getting detected by satellite or in case of porous surface (like desert), water gets absorbed before getting detected.

- Additional sources including rainfall data etc might help.
- Affected population estimates calculated using MODIS and LandScan Population grid are not recommended for micro planning at District, Tehsil or UC level because of its medium spatial resolution (1Km for population distribution and 250m for satellite data)
- High resolution data is required to assess the damages to the roads and bridges. MODIS doesn't provide enough spatial resolution to perform physical accessibility analysis.

Capacity of Agencies

WFP/VAM

- Monitoring of daily free Modis imageries (250m res) on national/provincial level
- More specific areas (such as Canal breaches) with more detailed information

OCHA

- Support analysis of satellite imageries
- Established reporting system of field data (f ex canal breaches and population affected). See map from Monsoon Update as example)
- Weekly monsoon forecast based on reported event, rain fall and predictions

IOM

- Field people (especially in camp setting scenario) to support ground truthing
- Open space analysis for evacuation site undertaken
- Technical expertise to support f ex hosting shared data

UNDP (not available in meeting)

- Establishing on-line GIS

UN HABITAT

- Under One UN, Establishment of Urban Observatory and Urban City profiling/Mapping using high resolution imagery (Quick bird) , a pilot study in eight cities of Pakistan.
- Digital Land Record system of Khyber Pakhtunkhwa province, Pilot for Charsadda district
- GIS Automation and setup of computer lab for Pakistan Census Organization (provincial offices)
- Landuse Mapping of Khyber Pakhtunkhwa and Land Record Mapping of Kachiabadies (Punjab)
- Institutional Capacity building of Rescue 1122 in term of GIS and Remote Sensing adaptation