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Standard Operating Procedure

Collaborative Spatial Assessment

CoSA

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Revision record

Revision	Date	Responsible Person	Description of change
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0.2	1 July 2010	JRC: GL	Revised draft, integrating Ispra workshop material
0.3	2 Sept 2010	JRC: CC	Second extended draft, modification of TOC
0.4	6 Sept 2010	JRC: CC, GL	Completion of draft version, for comment
0.5	7 Sept 2010	JRC: HvL, DAK	Revisions and comments
0.6	20 Oct 2010	WB: SG, KS, RE UNOSAT: EB, LdO, OvD, FP, OS	Revisions and comments
0.7	25 Oct 2010	JRC: CC, GL	Release 1.0, integrating Pakistan 2010 elements
0.8	29 Nov 2010	JRC: CC, GL	Revisions to 1.0 integrating elements from Ispra Workshop (November 8-9, 2010)

List of acronyms

CFP	Communication Focal Point
CoSA	Collaborative (geo) Spatial Assessment
DaLA	Damage and Loss Assessment
EC	European Commission
EO	Earth Observation
GFDRR	Global Facility for Disaster Reduction and Recovery
GIS	Geographic Information System
HRNA	Human Recovery Needs Assessment
JRC	Joint Research Centre
PDNA	Post Disaster Needs Assessment
RS	Remote Sensing
SOP	Standard Operating Procedure
SDI	Spatial Data Infrastructure
ToR	Terms of Reference
UN	United Nations
UNITAR	UN Institute for Training and Research
UNOSAT	UN Operational Satellite Applications Programme
WB	World Bank

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Scope

The purpose of this Standard Operating Procedure (SOP) is to establish uniform procedures pertaining to the preparation for, the performance of, and the reporting of collaborative remote sensing damage assessment (CoSA).

CoSA provides a synoptic, unbiased assessment over the impact area of a disaster, which feeds the two main recovery perspectives of the Post-Disaster Needs Assessment (PDNA) approach: i) the valuation of damages and losses carried out through the Damage and Loss Assessment (DaLA) methodology; and ii) the identification of human impacts and recovery needs carried out though the Human Recovery Needs Assessment (HRNA). The PDNA approach has been developed by the United Nations, European COmmission, and the World Bank as part of the implementation of the tri-lateral inter-institutional agreement on Post-Crisis Assessment and Recovery Planning signed by the European Commission, the United Nations Develeopment Group, and the World Bank in 2008.

CoSA is distinct from other remote sensing based assessments because it i) draws on the collaborative efforts of distributed capacities in remote sensing and geospatial analysis, ii) aims to achieve the highest possible accuracy in line with the requirements of the PDNA and iii) tries to do so under stringent timing constraints set by the PDNA schedule. A successful execution of a CoSA requires a consistent framework for the organization of a number of managerial, technical and communication tasks.

The current SOP will aid in ensuring credibility, consistency, transparency, accuracy and completeness of the CoSA. It is a living document, however, that will be enriched with new practical experiences and regularly updated to incorporate state-of-the-art procedures and new technical developments.

Applicability

Whereas the motivation of the SOP originated in the need to define the roles and responsibilities of the World Bank (WB), EC/JRC and UNITAR/UNOSAT teams that are partnering to the CoSA, the SOP's scope extends to other entities that may be involved in, contribute to or benefit from future CoSA activations.

This SOP is applicable in disasters that require an impact analysis effort where a joint effort is beneficial or required due to the magnitude of the event. In these disaster events, the analysis of remotely sensed data is expected to be a core component of the impact analysis. The SOP is primarily aimed at events for which collaborative efforts are distributed amongst teams that are geographically remote from each other. The SOP applies to all personnel involved in the planning, coordination, preparation, conducting and reporting of CoSA.

Background

The idea of creating this SOP was born following the Haiti January 12, 2010 earthquake and the subsequent experience in executing an ad-hoc CoSA in support of the PDNA. The international response to the Haiti earthquake was characterized, amongst others, by an outburst of geospatial analysis support, both in the form of public access to unique post-event satellite and aerial imagery and an outing of web-based collaboration tools and platforms in support of digital feature extraction. The joint collaboration between UNOSAT for the UN, the GFDRR for the WB and the JRC for the European Commission (EC) resulted in the provision of a comprehensive post-disaster damage assessment using remote sensing technologies. This collaborative effort helped in generating base figures which were fed into the PDNA analysis on damages and losses to the infrastructure sector. Lessons learned from the Haiti experience indicated that a high level of commitment and coordination are necessary both at the management and technical levels as well as in the field to implement a geospatial information strategy to support the transition from disaster assessment to recovery. Two technical workshops were jointly organized by the WB, UNOSAT and the EC/JRC to share the information management lessons learned from the Haiti[1,2] earthquake experience. The main lesson learned from the joint post-disaster damage assessment for Haiti is that operational procedures need to be established between the key partners involved in the collaborative effort to ensure efficient technical coordination, especially in protocols used for damage assessment, and effective decision making in the context of CoSA. The first discussion on the SOP took place during the second workshop at JRC. In late August 2010, the extensive flooding in Pakistan's Indus flood plains triggered another CoSA, in which the national geospatial analysis capacity[3] played an essential role. This experience led to a first overall review of the SOP[4] and resulting in updated content, i.e. this document.

Summary of method

Post-disaster damage assessment is part of the socio-economic and humanitarian impact analysis that takes place after a disaster has occurred. It usually follows the immediate emergency phase and is aimed at enumerating the resources needed to recover from the event's impact. Since 2008, a formal collaboration between the UN, World Bank and the EC exists which commits each respective organization to perform a joint PDNA. The DaLA methodology is embedded in the PDNA as the core

[1] Technical Workshop on Remote Sensing Damage Assessment – the Haiti Earthquake Experience, 27-28 April 2010, Palais des Nations, Geneva.

[2] PDNA lessons learnt workshop, May 20-21, 2010, Joint Research Centre, Ispra, Italy.

[3] SUPARCO, the Pakistan Space and Upper Atmosphere Research Commission.

[4] Pakistan PDNA lessons learnt workshop, November 8-9, 2010, Joint Research Centre, Ispra, Italy.

socio-economic analysis methodology. Human Recovery Needs Assessment (HRNA) is a more recently developed methodology, for which key indicators and core metrics are still evolving.

Remote sensing technology, combined with computer-based geospatial analysis, is recognized inside the PDNA as an essential contribution to provide unbiased, synoptic overviews of disaster impact, from which statistically representative damage estimates can be derived. Alternatively, remote sensing based damage assessment may generate a reference to check the plausibility of damage reports coming from other sources, including government reporting, e.g. for a sample of administrative units (districts). For large disasters, bundling the relevant expertise and resources of the respective contributing organizations is required to handle the large volume of work efficiently and within the usually strict time constraints of a PDNA exercise. Such a collaborative post-disaster damage assessment is conducted following specific technical procedures and requires a coordination of collective efforts. The CoSA is meant to be a crucial component of the DaLA because it assists primarily in the evaluation of damages and losses to physical assets. However, the timely delivery of unbiased assessment results over the impact area of a disaster may be very useful to all actors involved in the PDNA for the planning and coordination of additional data gathering and surveying activities. The outputs of the CoSA in terms of data and analysis are essential to decision makers that contribute to elaborating the recovery framework.

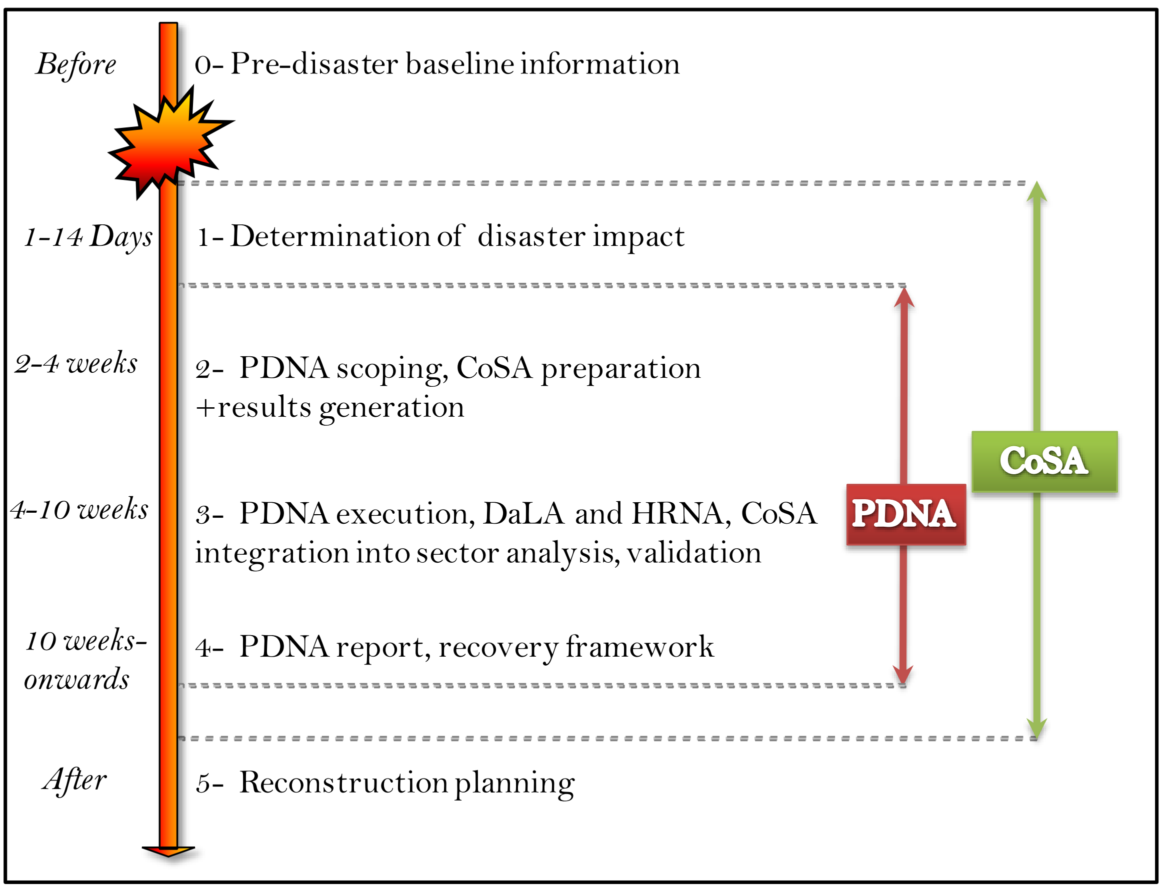

FIGURE 1. APPROXIMATE TIMELINE OF COSA WITH REFERENCE TO THE PDNA PROCESS

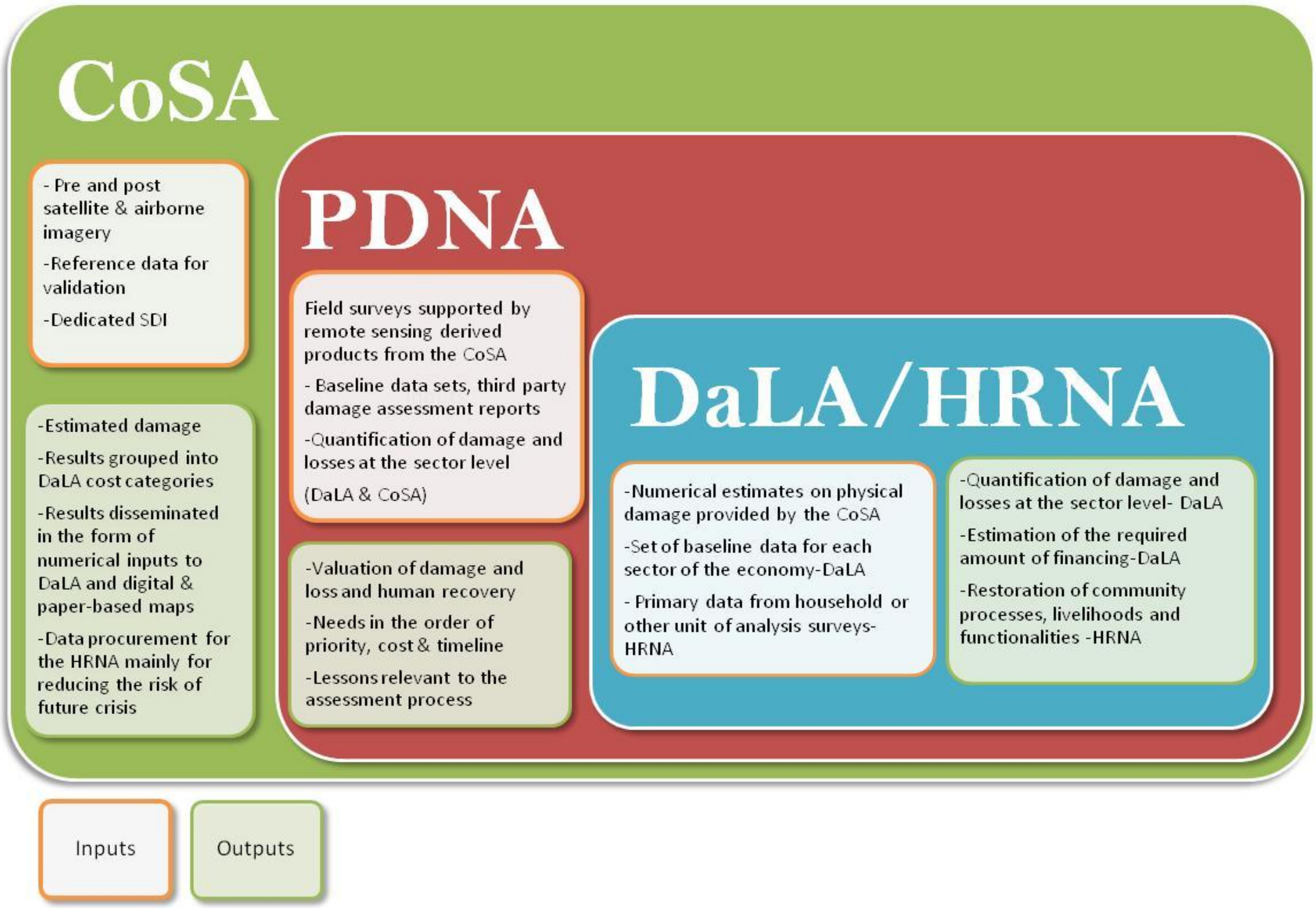

FIGURE 2. INPUTS AND OUTPUTS OF COSA, PDNA AND DALA/HRNA

The use of remote sensing techniques for impact assessment is based on the analysis of pre- and post-disaster satellite and/or airborne imagery, which has been prepared and geo-referenced to conduct (semi) automatic and/or manual interpretation of artifacts and patterns that relate to disaster impact. Interpreted results are assigned to damage categories and grouped in a pre-defined set of classes of interest, e.g., land-use or occupancy. For validation of interpreted results, reference data collected through ground-surveys are integrated for cross-comparison and compilation of ancillary information for class aggregation. At all stages of the workflow, quality control is carried out on intermediate inputs and outputs, spatial patterns and aggregated results. Summarizing the grouped interpreted results into meaningful DaLA cost categories is carried out by spatial aggregation and intersection with other geospatial covariates. Dissemination of results is provided as numerical inputs into the DaLA methodology as well as provision of digital and paper-based maps to the PDNA sector teams. Ultimately, consolidated results are provided as geospatial feature sets for use in post-PDNA settings.

The CoSA workflow includes a number of tasks that are logically and chronologically sequential, whereas the bulk analysis of large volume imagery can be carried out in parallel and distributed. Furthermore, tasks aimed at generating geospatial covariates and ancillary data for statistical aggregation may be carried out in parallel to the core impact analysis. A number of these tasks can even be outsourced to appropriate service provision from outside the collaborative team, including crowd sourcing platforms or other emerging collaboration frameworks. At all stages of the CoSA consistent communication is required to maximize complementarities, provide feedback to team collaborators, report on quality issues and monitor the progress of the joint effort towards the common goal of providing the DaLA inputs.

Definitions

Geospatial data: data that describes the distribution of features on the Earth's surface. The minimum spatial information is generally considered to be location, which is typically expressed using geographical coordinates. Geospatial data may also contain information about the shape and size (geometry) and relationships to other entities. Geospatial data can be registered by sensors (e.g. thermometer/temperature, gauges/water level, etc.). In the CoSA, the principal source of geospatial data corresponds to earth observation satellite or airborne sensors which record electromagnetic energy reflected/backscattered/emitted by the Earth's surface.

Geospatial information: information is data with a meaning, a semantic. Typical examples of information are the recording of all the damaged built-up structures in a given area, a population vulnerability index, a hurricane path, a flooded area. If a spatial context is associated with the information then this is referred to as geospatial information.

Quality Assurance and Quality Control (QA/QC): QA activities include a planned system of review procedures conducted by personnel not directly involved in the inventory/compilation process. Reviews, preferably by independent third parties, should be performed upon a finalised inventory following the implementation of QC procedures.

QC is a process by which entities review the quality of all factors involved in generation of the geospatial information including the accuracy of input data and the relevance of the methodology used for information extraction.

Remote Sensing based Damage Assessment: assessment of damages to man-made or natural environments and assets following a disaster using remote sensing technology and techniques. Remote sensing techniques are employed in the acquisition and measurement of data/information on some properties of objects, materials or features on the surface of the earth without any physical contact with the items under surveillance.

Standard Operating Procedures: a reference document, detailing the uniform set of procedures for performing a specific function. The main objectives of an SOP are:

- To systematically record all policies, processes and procedures currently followed
- To clearly indicate the actors and the flow of actions performed from beginning to end of the process chain

- To inculcate a culture of "Control Consciousness" among process owners and operatives
- To ensure a minimum level of accuracy and completeness in joint product results
- To observe shortcomings in these policies, processes and procedures and make suitable recommendations for improvements in the policies, process effectiveness, process efficiency, internal controls and compliance,
- To serve as a basis for disseminating knowledge on the above among the actors
- To enable adequate training to be imparted to concerned personnel with a view to making the operations person-independent.
- To act as a reference guide for Internal Audits.

In the framework of a PDNA, establishing a single set of procedures for damage assessment using remote sensing ensures that regardless of the location, type of disaster, or actors involved, the assessment of post-disaster damage will be consistent and robust.

Spatial Data Infrastructure (SDI): is computerized system environment for spatial data management aimed at providing [distributed] interoperable services for geospatial data storage, discovery and retrieval for use in thematic applications (e.g. damage assessment, disaster management, recovery planning).

Validation: can be defined as "a producer-independent process generating documented evidence to which degree the object under validation reaches predetermined specifications". Validation is performed at the interface between the geospatial information provider and the end user. It requires the collection of reference data (preferably field data).

Composition and functions of the CoSA team

A definition of key roles and technical and organizational competencies are required to implement the SOP. The following positions and corresponding assignments are only indicative. They are subject to changes depending on the dimension of the disaster event and the required competence. Upon deciding that a CoSA will be carried out, the following tasks are assigned: (In the organization chart below, starting from the top).

- **CoSA coordinator**: The CoSA coordinator assigns technical tasks to the contributing team(s) and sets the time schedule for intermediate and final deliveries, based on timing criteria of the PDNA. The coordinator will usually have the responsibility for ensuring the write-ups are prepared and that the appropriate inputs are entered. He/she ensures liaison with the PDNA coordination team for progress monitoring, communication manager and reporting. The coordinator will also work on reshaping / improving the CoSA procedures (the current SOP).

- **CoSA data manager**: He/she ensures management of distributed data sets, common toolsets, sample design and sample distribution, integration with ancillary layers, integration of external collaborative efforts, DaLA output generation. He/she is also responsible for managing a common Spatial Data Infrastructure and ensuring its accessibility to CoSA teams and the different PDNA sectoral experts. The data managers will also be responsible for the record management of all the internal and external procedures.

- **CoSA quality manager**: He/she is responsible for the quality control execution, data integrity checks, feedback into training loop, definition of requirements for the collection of ground reference data and for performing the validation of geospatial information before its integration into the PDNA.

- **CoSA country focal point (CFP)**: He/she is the point of contact for the CoSA team stationed in the affected country. He/she will communicate with the in-country PDNA coordinator, the local PDNA sector teams and government counterparts about the requirements that can be addressed by CoSA. When approp**riate the CFP will supervise t**echnical work carried out by one or more national technical capacities. He/she will attend the meetings of the various clusters, report to the CoSA coordinator on specific sector needs and update the clusters on the CoSA work progress and ensure the proper local distribution of the intermediate deliverables. One or more persons could be designated as CFP to cover all these responsibilities.

- **CoSA team leaders**: They ensure daily management of operational tasks of local teams, training of interpretation team, internal quality control, reporting to CoSA coordinator. Team leaders are responsible for defining the methodologies and interpretation keys for information extraction from remote sensing data. Across teams, they will work together on the definition of a common approach to be implemented by the different operators. Team leaders will also prepare the field plan for validation, organize the logistics (equipment data preparation, trip planning, meetings, etc.).

- **CoSA operators**: They execute technical tasks in support of the CoSA including the gathering of relevant geospatial data (e.g. field data, third party reports and data sets), the interpretation of imagery, the generation of relevant ancillary data layers and the compilation of reporting material.

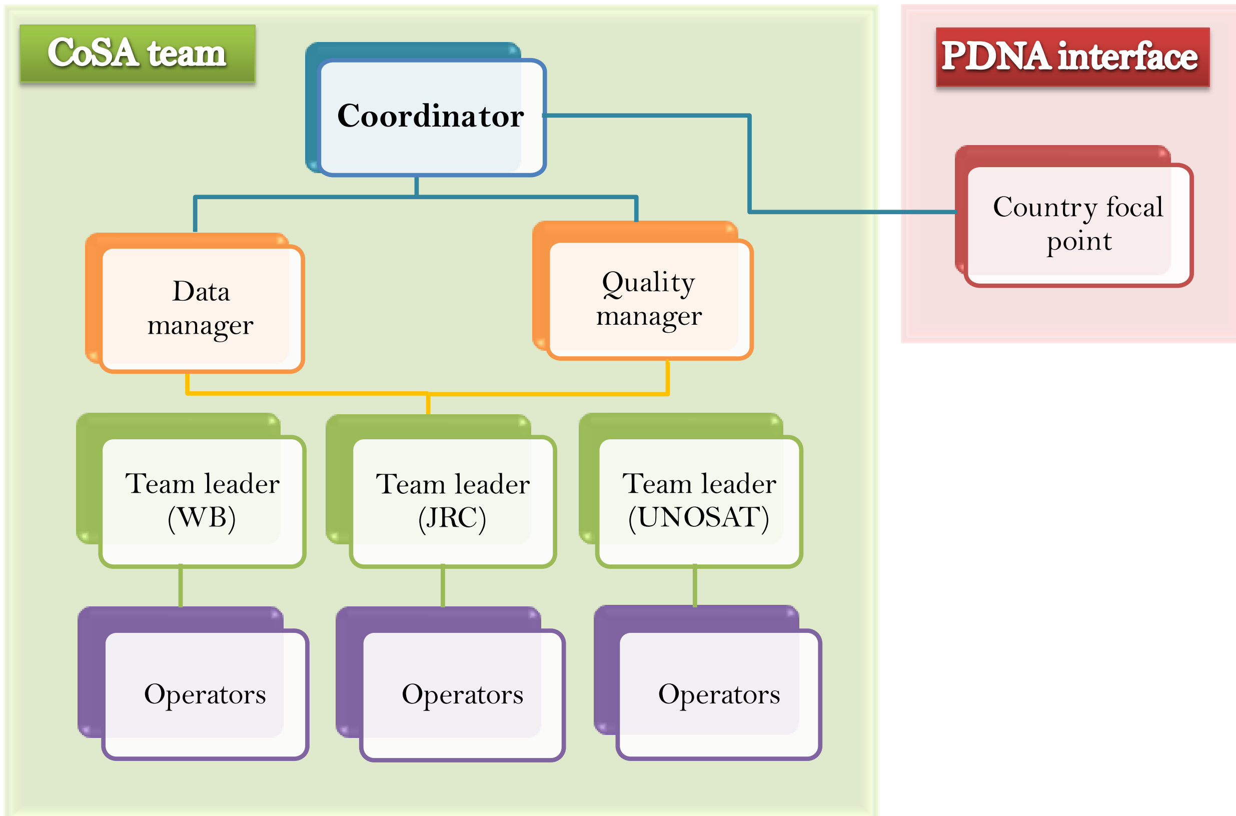

FIGURE 3. THE MAIN ACTORS IN THE COSA

Procedural steps

The CoSA requires a comprehensive set of organizational and technical procedural steps that are aimed at generating the highest possible quality output within the PDNA time constraints. An overall guiding principle is to ensure that each of the specific procedures is carried out by the most capable operator(s) in the collaborative team and in the most effective manner.

1. Pre-PDNA preparedness (CoSA partners)

Continuous communication between the partners of the CoSA is vital for performing the procedural steps described in the SOP. Between PDNA occurrences, communication through meetings, workshops, teleconferences and other types of new technologies is essential for a better preparedness before an event strikes.

In the case of a disaster, a meeting of the CoSA partners is organized to designate the CoSA coordinator and the CFP and to prepare the first pre-PDNA products that may consist of the following:

i) The impact map is a standard product generated before the PDNA, ideally one day following the event. It aims at providing an overview of the areas impacted at a small spatial scale (administrative boundaries at 1:100,000 to 1:500,000 map scale). This type of product is based on several available sources immediately after the disaster such as satellite imagery, reference data, field and media reports, etc. It is meant for communication and informational purposes and targets primarily the institutions participating in the CoSA (e.g. the UN, the WB and the EC).

ii) The PDNA preparation map is an evolutionary map, triggered by the PDNA scoping mission. It is generated between one and two weeks after the event allowing a closer view of the extent of the event (first or second level administrative boundaries at spatial scales ranging between 1:25000 and 1:100000). The effects of the event can be identified in terms of broad degrees of severity (low, medium and high) with some indications on the likely affected sectors. This type of product can be generated either using remote sensing analysis or by a desk review (cross-validation) of the different emergency mapping products published during the first weeks after the event. It may be used as support document during the negotiations with the government for the definition of the PDNA.

iii) The PDNA readiness review is a report triggered by the scoping mission with the purpose of informing the CoSA partners and the scoping mission on the Earth Observation strategy and the outputs planned for the PDNA. This report is also used as an input to the PDNA ToR. It represents the preparatory document before the actual triggering of the CoSA.

2. *Triggering and tasking (CoSA coordinator + team leaders)*

CoSA is triggered on the basis of the following criteria:

- The estimated size of the disaster impact, relative to the coping capacity of the local authorities. The event severity is an important criteria for deciding on the numbers of institutions to be involved: e.g. for small events only one CoSA team may be activated, for medium events two could be required and for large events all three JRC, UNOSAT and the WB CoSA teams would be involved. Alternatively, assignment may be based on the specific expertise that would be required;
- An initial estimate of the likelihood that the government of the impacted nation will request a PDNA.

The starting point of CoSA is focused on a preliminary assessment of resources that are required to carry out the CoSA. This includes an inventory of relevant reference data for characterization of the pre-event situation, a feasibility analysis of relevant satellite imagery acquisitions, and pre-alerting of CoSA partners on mobilization of operational capacities.

A monitoring activity is started to systematically collect media and situation reports, review relevant internet-based fora and analyze early warning system outputs and weather reports. This activity is primarily aimed at refining the definition of the impact area for imminent tasking of satellite data and assessing the feasibility to rapidly deploy reference data collection on the ground.

CoSA partners report back on available in-house data resources and operator capacity that can be mobilized on short notice. Each of the partners will report on preparation of procedures for which specific expertise is available or for which external expertise can be mobilized, including in-country capacity in support of reference data collection.

Full CoSA activation requires an official decision by the EC, UN and the WB based on the official request for a PDNA from the government of the affected country. Such a request is usually received at least 1 to 2 weeks after the immediate disaster event. In the meantime, CoSA partners as well as external entities may already have been involved in "rapid mapping" exercises that are triggered through other mechanisms (e.g. International Charter calls, internal institutional requests, emergency response triggers). Outputs from these activities are systematically collected to allow further fine-tuning of the CoSA scope and effort. CoSA readiness is communicated to the team in charge of PDNA preparation.

3. Data procurement (CoSA data manager, country focal point)

Data access

Event impact assessment using remote sensing data is preferably carried out on image data sets that provide a complete coverage of the impacted area and at sufficient spatial and radiometric resolution to delineate the physical signature of the event impact. In practice, however, a trade-off must be made between these parameters, since increased spatial or radiometric resolution is usually available only for limited image coverage. Alternatively, a combination of sensors may be used, for instance, to estimate total impact area from a lower resolution sensor and use a sample of high resolution image sensors to look at details. This practice is often enforced due to a limited selection of available sensor options directly after the event, or a lack of comparable resolution imagery for the pre-event situation.

Several mechanisms exist to procure post-emergency image data for a CoSA exercise:

- Collaborations between space agencies exists that pool satellite imaging capabilities for use in emergency response contexts (e.g. the International Charter Space and Major Disasters, Sentinel Asia, NASA's rapid response). Data is typically made available to registered users for a limited scope and time and includes a range of low, medium and high resolution optoelectronic and SAR sensors.

- Specific programmes aimed at restricted distribution of high resolution satellite data (e.g. USGS Hazard Data Distribution System) or geospatial emergency response services (e.g. the EU Global Monitoring Environment and Security (GMES) SAFER project) in post-emergency contexts. The latter is currently restricted to the supply of derived impact assessment results as map output. The EC Instrument for Stability can also cover procurement of limited satellite data by the EC CoSA partner.

- CoSA partner organisations have commercial arrangements with relevant imagery suppliers, especially for high and very high resolution optoelectronic and SAR sensors, which include options to rapidly task satellite resources post-emergency. Licensing arrangements exist that would cover sharing of such data amongst a limited set of CoSA partners.

- National organisations in the affected country, if not impacted by the disaster, may operate receiving capabilities for sensor data of interest. Special arrangements in the framework of the PDNA should be set up to make such data available for analysis by (other) CoSAs. Alternatively, the national organization could become the core CoSA team, with others contributing to specific tasks, e.g. country focal point, QA/QC, field surveys.

- In exceptional cases, a CoSA partner may trigger specific actions to collect post-emergency airborne data sets, usually at spatial resolutions that are superior to the best available satellite sensors, or including special purpose data collections (e.g. LIDAR flights). Such initiatives often depend on the availability of the technical instruments on a short-term basis and, most importantly, authorisation in the affected country.

- Third parties (e.g. Google Inc., Pictometry) may decide to release special purpose spaceborne or airborne data collections in the public domain, usually through propriety interfaces. Such organisations may be tasked to collect additional data via electronic *fora*.

Image supply varies strongly from one disaster event to another, depending on temporal and geographical characteristics and conditions that determine the success of data capture by the various sensors (e.g. atmospheric conditions, agility of the sensor, programming flexibility, commercial considerations, etc.).

Similar mechanisms may be used to collect relevant pre-event reference data to assist in the delineation of impacted assets. In the selection of reference pre-event imagery actuality, spatial resolution and spectral details are the relevant parameters. These parameters should match, at least, the expected quality of the most relevant post-event imagery. In practice, limited availability of comparable quality data and costs will determine this selection to some extent.

For CoSA, a shared data access mechanism is required at both the meta-data level, to inform CoSA partners about available data holdings, as well as the image data itself. The latter requires the respective CoSA owner of the data to have arranged for the appropriate licensing for use in a CoSA context. Sharing of meta-data allows individual CoSA partners to search for and acquire relevant complementary data sets through their respective procurement arrangements or file request for additional tasking through the mechanism outlined above. This assumes that meta-data records are updated regularly, to reflect ordering and procurement status of such additional data. Increasingly, relevant image data may become available in third party on-line archives. A dedicated CoSA action to describe the meta-data of such holdings and store these in the common repository is essential.

The common repository should take the form of an on-line web mapping application that allows visualisation of meta-data and the exporting of meta-data records in OGC compliant formats. Records are loaded via standard uploading mechanisms, and updated via on-line forms.

Relevant geospatial data layers

Besides pre-event reference and post-event impact imagery, the CoSA is often carried out in situations where ample reference geospatial data exists in electronic form. Discovery of such data usually starts in the early stage of PDNA initiation (and is typically part of the country focal point responsibility).

Essential geospatial thematic data sets include the following:

> **Assets-at-risk (exposure)**, i.e. geospatial layers allowing localization, characterization and enumeration of the impacted assets. Depending on the event, these include built-up characteristics, transport, critical infrastructure, agricultural land, forest, etc.;
>
> **Hazard**, i.e. geospatial layers that are covariates in determining the severity of the event impact. Depending on the event, these include digital elevation models and hydrology, weather parameters, geological seismicity and soil maps, erosion sensitivity, etc.;
>
> **Generic data layers**, i.e. administrative boundaries, cadastral maps, socio-economic indicators, census information, etc.

Quality parameters determining suitability of relevant geospatial data sets include scale, detail of attribute data, local and national availability, restrictions, homogeneity, consistency, actuality and data quality.

Initially, reference data from globally consistent data bases may be consulted (e.g. GIST, GAUL) as a minimum standard. Increasingly, relevant datasets become available via internet through local or international initiatives (i.e. OneResponse.org, Open Street Map, regional centers of expertise, NGO contributions), Metadata of such sets should be maintained in the central CoSA repository. Relevant data (reference and baseline information over affected areas) are typically available with government institutions (e.g. the National Survey, Census Bureau, Statistical Office, etc.). Early awareness of the local situation is extremely important, so that the PDNA coordinator can arrange for access to such data via the PDNA government counterpart[5].

Furthermore, quality labels should be added by CoSA actors that perform cross-analysis on data sets covering the same themes. Current "best of class" sets, which may be compositions of reference sets, should be made available via the repository.

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[5] In many countries, access to detailed and recent digital map information is restricted. Furthermore, government institutions in charge (e.g. Ministry of Defence, Ministry of the Interior) may only be indirectly involved in PDNA. Awareness of PDNA needs need to be communicated early in the preparation phase.

In cases where reference data is not of sufficient quality, the CoSA coordinator may decide to task the team with the derivation of the relevant data layer from the reference and post-event imagery. Alternatively, such data layer generation may be outsourced to a technical third party or crowd-sourced (e.g. Open Street Map HOT)[6]. This decision is primarily driven by the needs of the PDNA sector analysis, esp. when core baseline sets are missing.

4. Remote sensing based damage assessment (CoSA team leaders + operators)

Data preparation

Remote sensing imagery is usually provided in raw, intermediate or pre-processed formats. Raw signal data usually requires elaborate processing, that can sometimes only be carried out with dedicated software (e.g. SAR processing). Intermediate and pre-processed imagery is usually corrected for system artifacts, calibrated and geo-corrected. However, detailed geo-referencing and preparation for further processing (sub-setting, masking) may still be required. In principle, such processing should be done at the CoSA team that procures the data, to avoid duplication of basic processing steps. Only the final, geo-referenced imagery should normally be shared across CoSA partners. Processing steps should be described in the corresponding metadata records.

For specific process issues, knowledge on CoSA processing capabilities (including software tools) should be shared in CoSA partner profiles.

Automated generation of relevant indicators

Among the possible methods for generating the damage assessment figures, some relevant indicators can be automatically produced from (combinations) of imagery. These may include the results from classifiers or thresholds applied to the imagery, difference images for change detection, output of dedicated algorithms that highlight image artifacts representing impact phenomena, etc. CoSA partners should share descriptions of the processes they use to generate such indicators, preferably with references to practical use in similar impact analysis cases. Depending on processing requirements (speed, dedicated architecture), a single CoSA partner may be tasked to process all imagery on behalf of the team. Indicator imagery should than be shared, typically as an ancillary layer in support of the interpretation process.

Interpretation toolset selection

[6] Outsourcing of technical tasks requires drafting of consistent Terms of References, including description of data specification, methodologies and quality assurance criteria for acceptance of result sets

A key process in impact assessment is the visual interpretation of the imagery sets aimed at outlining and categorizing impact artifacts, and involving multiple CoSA operators. A common set of requirements of toolsets to support visual interpretation includes:

- synchronized viewing of multiple images of the same area, in which respective images are properly geo-referenced (i.e. showing the same location). Views may include pre- and post images in combination with indicator imagery;
- a point-and-click function to rapidly assign a classification label to the current image location (in case of point-based impact analysis). For line or polygon digitization, drawing tools are required;
- a progress indicator to show sample selection and completion status to the CoSA operator, and, if relevant, of the CoSA team(s);
- automated and/or manual result synchronization to local file and central CoSA repository;

Each CoSA team is responsible for toolset implementation, but sharing best practice as (open source) solutions should be considered. Individual CoSA team results should be collected regularly and shared in a common on-line repository.

Interpretation keys, instructions, training

Disaster impact varies by event category and with local circumstances. Interpretation of impact artifacts builds on a set of common knowledge on event impact, expanded with experience that is derived, iteratively, from the actual interpretation process. Before starting the interpretation process, CoSA teams need to be collectively updated on the common knowledge, preferable with comparable data examples of similar events. The changes in the physical properties of the observed surface from the normal state (i.e. flooded/non flooded), which are related to the event impact need to be explained together with the characteristics of the remote sensing sensor (spatial, spectral and temporal resolution) and the environmental conditions at the time of image acquisition (e.g. atmospheric conditions, surface characteristics, seasonal effects, etc.)

This is particularly relevant for sensors that provide radiometric channels beyond the familiar "natural colour" combinations, such as optical sensors with multiple visual and infrared channels and Synthetic Aperture Radar (SAR).

The definition of interpretation keys is based on the thorough understanding of the expectations and limitation on detectability of relevant image artifacts. Positive and negative detectability is illustrated with training examples for the defined interpretation set-up, preferably taken from the actual event data, and shared via the common repository with the other CoSA teams. A separate set of samples is created to serve for training of the CoSA operators. The analysis of the training results determines whether detectability issues are correctly understood, or require further illustration. The training samples will be selected by the CoSA team leaders and shared between the different teams through the common SDI repository.

In the course of the interpretation, examples will turn up that further illustrate common and special cases of artifacts. Representative samples of such cases are described and added to the training sets by CoSA team leaders , so that CoSA operators are immediately aware of the event specific cases.

Sample design, distribution and tracking

The distribution of interpretation tasks amongst and within CoSA teams requires a sampling of the impact area that aims at balancing the workload. A common method is to use grid samples, with grid size depending on image resolution and size of the detectable artifacts. A stratified sampling approach is generally preferred, with the strata defined by the (expected) density of the impact artifacts. For each of the strata, sample clusters are distributed to individual CoSA operators. This guarantees a more or less equal distribution of the initial workload, while the clusters minimize maneuvering over the full image set and maximize the use of correlation between locally significant impact artifacts.

A separate random sample of grid cells should be distributed as a control sample. These samples are interpreted, at least, by 2 different CoSA operators, to test for operator bias, and further refine training samples.

Interpretation results should be time-stamped, operator-marked and flow directly into a versioned central repository, so that cross-checks and progress reports can be derived on the fly. Differential progress may be used as an indicator to estimate overall damage at an early stage in the interpretation process, or to correct the stratification and sample distribution.

5. GIS-based damage estimation (specialized CoSA team)

In case of the availability of reliable and detailed ancillary data (e.g. soil types, building categories, transportation systems, etc.), it is possible to use remote sensing data to obtain building inventory and to integrate all this information in a GIS-based loss estimation model to estimate the damage (Eguchi et al., 1997). This approach can be carried out in parallel with the remote sensing based DA. GIS-based damage estimation represents an alternative fast approach for a preliminary DA. It requires expertise in both the use of GIS and in loss estimation methods. Relevant expertise should be sought according to the type of hazard event e.g. earthquake engineers, hydrologists etc. The outputs of the model can then be cross-compared to the remote sensing based DA and to field reconnaissance data for the refinement and the verification of the model.

6. Quality assurance/quality control (CoSA quality manager + data manager)

The QA/QC task within the CoSA aims to improve transparency, consistency, comparability, completeness, and confidence of the derived damage estimates. The outcomes of the QA/QC process may result in a reassessment of the damage inventory. For example, if the quality of the input data is found to be lower than previously thought and this situation cannot be rectified in the timeframe of the PDNA, the uncertainty estimates ought to be re-evaluated and a new revised version should be released.

Quality Control (QC) is a system of routine technical activities, to measure and control the quality of damage assessment as it is being performed. The QC system is designed to:

(i) Provide routine and consistent checks to ensure data integrity, correctness, and completeness;

(ii) Identify and address common errors and omissions;

(iii) Document and archive damage assessment material and record all QC activities.

(iv) Check the political sensitivity of the final product.

QC activities include general methods such as accuracy checks on input data (e.g. positional accuracy of remotely sensed data) and the use of approved standardised procedures for estimating uncertainties, archiving information and reporting.

Quality Assurance (QA) activities include a planned system of review procedures conducted by personnel not directly involved in the damage assessment process. Reviews, preferably by independent third parties, should be performed following the implementation of QC procedures. Reviews verify that data quality objectives were met, ensure that the estimated damages represent the best possible assessment given the current state of data available and scientific and technical knowledge.

In the current SOP the focus will be on the (QC) measures which are tackled by the CoSA quality manager, while QA activities should be performed by a third party. QC measures are meant to optimize the quality of the DA performed by different teams and several image interpreters. QC should be performed during the DA production phase in order to identify, at an early stage, major deviations and excessive variability around quality specifications and to recommend immediate remedial actions.

Control of operator error, subjectivity

During the process of information extraction from remote sensing imagery (whether it is manual or semi-automatic), several types of errors may arise. It is possible to distinguish at least three groups of operator's errors:

1) errors due to negligence[7]

2) errors related to permanent changes in the technical instructions and work procedure,

3) errors caused by a limitation of the data (e.g., low spatial resolution of the imagery), and

4) errors related to the personal capacities and skills of the operator.

[7] CoSA operational interpretation is often high volume work carried out under time stress.

It is possible to minimize the operator errors with reference to quality specifications (acceptable ranges) that will be evaluated on the basis of a control sample. The CoSA quality manager will determine the control sample, its size and define the acceptable ranges. As soon as early damage assessment results become available, he/she will analyze the variability of the DA between the different interpreters and accordingly request a revision of the work.

QC of input and ancillary data layers

In addition to the quality check of the damage assessment, any input or ancillary data used for performing the remote sensing based damage assessment should undergo a systematic QC check.

This includes checking:

For input data

(i) accuracy of geo-referencing and ortho-rectification of aerial an satellite imagery

(ii) against independent data sets such as other images or vector products;

(iii) the cloud coverage of images to ensure that cloud coverage extent does not impede the use of the data;

For ancillary data

(i) metadata compliance especially prior to the integration of the geospatial information into the Spatial Data Infrastructure (SDI)

(ii) data format and suitability for integration within a GIS

(iii) completeness of the information (e.g. all tables and fields are present)

(iv) date of last update

(v) presence of contact information

(vi) presence of documented evidence on the limitations of the data

(vii) presence of description on the methodological steps used for deriving the data

In brief, it is important to ensure that the data adhere to the Principles of Humanitarian Information Management, i.e. accessibility, accountability, impartiality, inclusiveness, interoperability, relevance, sensitivity, sustainability, timeliness, and verifiability (Global Symposium +5).

Sensitivity analysis, error budgets

Among the other quality indicators to be checked by the QC procedure are the sensitivity criteria that are dependent upon the accuracy of each single dataset used in remote sensing damage assessment analysis. When several sources and types of geospatial datasets are crossed during a spatial analysis, accounting for the accumulation and propagation of errors will become even more complicated because of interactions among the datasets (or variables in statistical terms).

The appropriate statistical approaches for this purpose may be sensitivity analysis including error budgets. An error budget can be considered as a catalog of the different error sources that allows the partitioning of the variances according to their origins, and shows the effects of individual errors and groups of errors on the quality of an output. The goal is to account for all major sources of errors and uncertainties (related to sampling, data collection, processing, etc.) to improve modeling, mapping, and management decisions.

Locating the sources of uncertainties, modeling their accumulation and propagation, and finally quantifying them are critical to control the quality of the generated damage assessment.
The CoSA quality manager will define and implement a spatial uncertainty and error budget methodology. This approach will allow the major uncertainty sources and their spatial variation to be identified and used to suggest a rationale to reduce errors in damage assessment generation (Wang, 2005)

7. *Validation (CoSA quality manager)*

The purpose of the validation is to assess the accuracy of the damage assessment with reference to field surveys or to other sources of sample reference data with a high level of reliability (e.g. remote sensing imagery with a better spatial resolution than the input data used to generate the damage assessment). Validation should establish a set of acceptance ranges (tolerances) for the thematic and positional accuracies of the damage assessment determining whether the final products are accepted or rejected. The process of geospatial data verification includes confirmation by examining or providing objective evidence that the specified acceptance criteria are met.

Even if several QC checks are carried out during the production phase, a close attention must be paid to validation criteria that would make the final product appropriate for its intended use.

Validation is also essential for calibrating and scaling the remote sensing results. For instance, where moderate damage classes are difficult to identify using remote sensing, statistical or deterministic models based on field observations could be used to extrapolate the number of affected buildings that fall into the moderate damage classes.

The following schema shows the flow of data through data collection, data processing and analysis and information validation, review and assessment. It illustrates the quality approach applied to geospatial data flow within the CoSA.

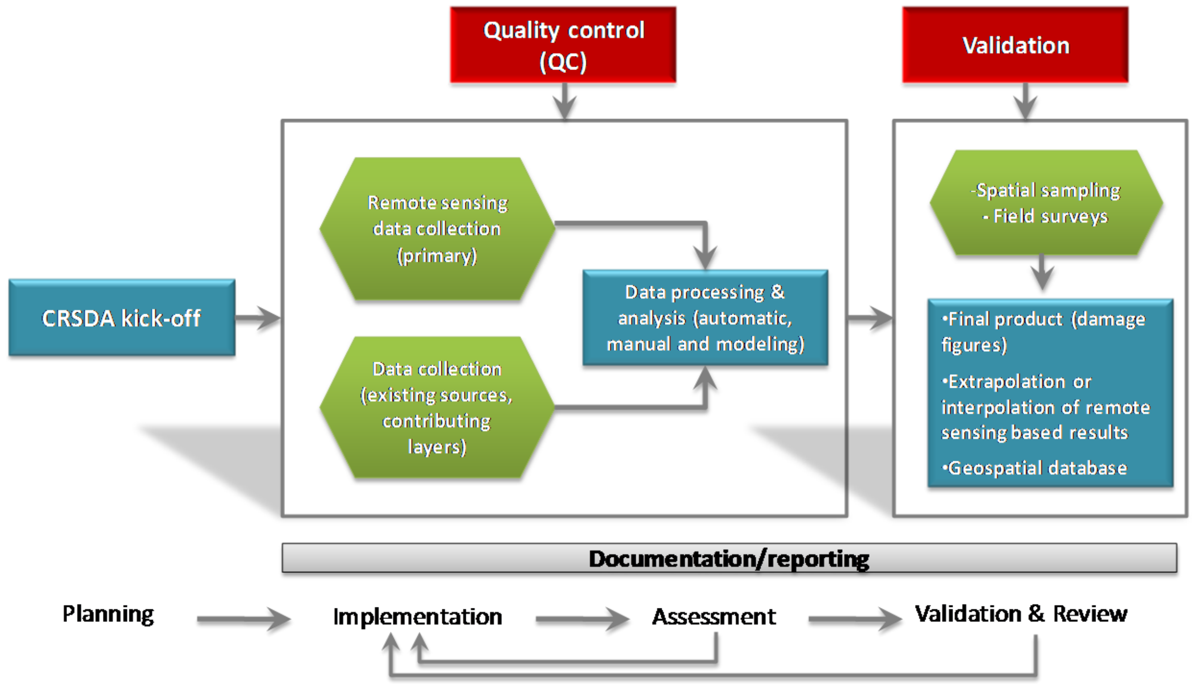


FIGURE 4. THE QUALITY APPROACH TO ADDRESSING THE GEOSPATIAL DATA FLOW WITH THE COSA

Reference sources

Validation depends on the existence and availability of independent reference data for thematic and positional accuracy assessment. The following datasets are recommended for use as inputs for the validation process within the CoSA:

1. Field data collected from field surveys (geo-coded field photos, GPS control points, field maps, reports from local communes, etc.)

2. Reference topographic maps

3. Reference imagery from satellites / aerial photos (better or same spatial/temporal resolution as initially used data set). The reference imagery should be collected on a sample basis for estimating the thematic accuracy of the damage assessment.

4. Public and private geo-databases with relevant thematic layers

5. Previously validated geo-information products

In general, the resolution of the reference data set (raster/vector) should be equal or better in resolution than the image/vector data used for the initial generation of the product under validation.

When reference data or materials are acquired from external sources, it is important to verify that the materials are received in the correct form and to verify their reliability, completeness and consistency prior to their use as a reference for validation (Corbane et al., 2010).

Planning and conducting of field surveys

Field surveys for field data collection represent an essential component of the CoSA process. They will be planned as soon as the CoSA is triggered and are ideally conducted in parallel to the remote sensing based damage assessment. Preliminary damage figures can be then validated periodically and major deviations can be identified at an early stage. This helps defining and documenting error budgets and corrective actions that should be implemented before the release of the final damage figures.

For major events and large affected areas, field surveys might expand beyond the deadline for the submission of the PDNA report. In that case, the released version of damage figures should clearly state the level of accuracy estimated at that stage and the plan for additional validation giving a clear indication on the target date for the delivery of the final verified results.

The CoSA quality managers will designate a group of trained field surveyors. They will also carefully plan the sampling schema, the logistics and material needed, design the validation forms and decide on the frequency of field reporting, including requirements for electronic uploads to the SDI. Terms of reference for field data collection will be established at the kick-off of CoSA. The CoSA country focal point will be involved in field survey logistics.

Coordination of field surveys with local counterparts is essential during the planning and implementation phases of the validation process. Involvement of local experts in the field survey may help in a better understanding of the situation and logistical preparation. Ensuring a proper training of all field operators is necessary before the deployment of the teams in the field. Dedicated training sessions should be organized as soon as a CoSA is triggered and the local counterparts are identified.

Sample design for field data collection

The strength of conclusions that can be drawn from data has a direct connection to the sampling design and deviations from that design. CoSA quality managers will be responsible of the design of a spatial sampling schema tailored to the available technical and human resources.
The following considerations need to be taken into account during the planning phase of the field-based validation process:

1) The methodology underlying the sample selection should be repeatable and should minimize the potential for human bias. Two key criteria should be kept in mind when designing a sampling strategy:
- The sampling strategy must be based on readily available material (e.g. local street maps) and not on sophisticated datasets (e.g. age of construction).
- A compromise between efficiency and perfection must be sought.

2) Sampling areas will be defined according to the two following general principles:
- significance: their dimension must be sufficient to ensure with high probability that the accuracy estimates are reliable;

- representativeness: their composition must include all relevant information the survey is supposed to check (e.g. representative of all damage classes, land use classes, occupancy classes, of all types of buildings and storey levels, of building densities, etc.).

  The choice of sampling areas is also driven by the importance of information to be validated; the availability of information sources and cost of acquisition and advice from local experts for field mission, to define a detailed strategy optimizing the effort.

3) Cluster or stratified sampling can be applied for thematic accuracy assessment taking into account budget and time constraints:
   - Cluster sampling can be used because of the "natural" grouping of damage into urban blocks or into geographical regions. In that case, the total population is divided into clusters (e.g. urban blocks) and a random sample is selected from the clusters. In single-stage cluster sampling, all the elements from each of the selected clusters are used. In two-stage cluster sampling, a random sampling technique is applied to the elements from each of the selected clusters.
   - Stratified sampling can also be used when there is an evident variability in the damage levels with respect to certain factors such as type of construction, soil type, density of buildings, etc. In that case, the population (e.g. damaged buildings) is grouped into relatively homogenous subgroups before sampling (e.g. stratum of low density buildings) and then random or systematic sampling is applied with each stratum. This often improves the representativeness of the sample by reducing sampling error.

4) If the purpose is to determine the overall accuracy, or the accuracy of an individual category (e.g. one specific damage class), then the appropriate sample size should be preferably determined using the binomial distribution which depends on 1) the level of acceptable error one is willing to tolerate and 2) the desired level of confidence that the actual accuracy is within some minimum range. If we want to determine the generation of an accuracy matrix including all the categories, then it is preferable to use the multinomial distribution (Tortora, 1978).

Sample design considerations are essential before conducting the field survey. Because accuracy assessment is expensive, it is important to carefully plan the sampling designs knowing that some are better suited for descriptive statistics while others are appropriate for analytical techniques. It is also crucial to pay close attention to both the *practical limitations* (e.g. limited access to some areas because of the debris, time constraints for the PDNA deliverables, number of field operators and their familiarity with the area, security concerns) and the *statistical requirements* when performing validation.

Feedback of validation into operational workflow

Validation should be preferably carried out in parallel to the QC and the remote sensing (or model) based damage assessment. At least two validation reports should be generated during the CoSA process. The first report will identify the major deviations from the target quality objectives and propose corrective measures. The second report will be issued at the end of the CoSA process and will be used for documenting the validation methodology and the estimated accuracy of the overall damage figures. A continuous monitoring of the correct implementation of quality measures should be ensured by the CoSA quality managers. Careful attention should be given to the proper versioning of the intermediate results along with a statement on the estimated accuracies. Finally, the outcome of the validation should feed into the implementation phase of CoSA for quality improvement of the intermediate products and to minimize the differences between preliminary damage assessment results and the final overall figures.

8. Result compilation for PDNA (CoSA coordinator + team leaders)

The scope of this procedural step is the aggregation of the "raw outputs" into statistical and geographical results that are meaningful to the PDNA sectoral needs.

This step is challenged by:

(i) the need for the generation of results tailored to the DaLA requirements requires a familiarization with the different sector-dependent approaches and knowledge of the procedures used in the DaLA methodology. It is the CoSA coordinator's responsibility to ensure that the generated outputs are appropriate and conform to the DaLA needs.

(ii) the need for an awareness of the intermediate DA results within the PDNA. The CoSA country focal point will ensure the interfacing with the different PDNA cluster/sector leaders. The CFP will communicate the intermediate results to the PDNA sectors and make sure that new releases are correctly delivered to the respective PDNA sector clusters.

(iii) the need for a synchronization with the PDNA sectors' schedules. This falls again under the responsibility of the CoSA coordinator and country focal point who will follow up the planning of each sector to guarantee the proper and timely integration of the final DA results into the different socio-economic sectors. A schedule for the delivery of the intermediate results and the final aggregated figures should be established in close collaboration with the PDNA sector leaders to ensure an optimal time management of the CoSA process.

(iv) the need for careful manipulation and integration of the contributing geospatial data layers. An example could be the use of the land-use layer (or exposure maps) in combination with asset values and the remote sensing based DA. It is essential to first study the relevance of the land-use for the estimation of damages and losses in terms of: the typology used and its relationship with the asset values, the matching or proximity between the dates of the land-use map and the economic and social values, the appropriateness of the scale of the land-use map for the estimation of the damages and losses for the different socio-economic sectors.

Accordingly some key decisions regarding the timing of the DA results' dissemination must be taken in agreement with the PDNA coordinator and the cluster/sector leaders. This should be done prior to the PDNA, preferably during the scoping mission. Another key decision point is the agreement between the PDNA and CoSA coordinators on information requirements to be derived from remote sensing image analyses. These requirements will be clearly defined in the ToR of the PDNA and should be reasonably achievable with respect to the capacities of the CoSA team, its mandate and the time planning of the PDNA.

Reporting outputs consist of:

- analytical maps (digital or paper maps) and damage assessment statistics (reports and tables) showing the main affected sectors and summarizing damage statistics by sector at an appropriate scale or by administrative unit. These quantitative products are obtained by overlaying the damage assessment results with sector-dependent datasets (e.g. an inventory of assets, cost of the different building-types, location of schools, hospitals and main government buildings, etc.).
- where moderate damage classes are difficult to identify using remote sensing, statistical or deterministic models could be used to extrapolate the number of affected buildings that fall into the moderate damage classes. Expert systems (knowledge-based models) could be very useful at this stage for a good approximation of the moderate damage. Information collected from field surveys is usually used for determining relative distributions of damage grades for establishing the extrapolation rules of the expert system.
- an atlas of damage to infrastructures that can provide an overall view of the damage pattern. The atlas should preferably depict not only the physical damage to infrastructure but also summarize the damage per land-use type. The atlas could be very helpful for conducting the field surveys and for focusing the recovery and reconstruction plan by geographical area.
- the different outputs resulting from remote sensing analysis can be used to develop a geodatabase that could be shared with national counterparts and with the different PDNA actors involved in the recovery planning.

Feedback into operational work

The results of integrity checks, QC and validation of all input and output data should be documented both in the metadata and in the final damage assessment report. The estimated quality indicators can help to better understand the limitations of the overall damage figures. Knowing the error associated with each type of dataset used, it is possible to estimate the overall error and to try to minimize it using appropriate modeling tools or additional field surveys.

9. Reporting and dissemination (CoSA coordinator)

CoSA report production

An intermediate internal reporting process should be planned at the beginning of the CoSA. The intermediate reports will include information on the work progress, the outcomes of the progress meetings, the technical/methodological problems and any deviation from the initial planning.

The CoSA staff will compile all the results of the damage assessment into an external report that will be delivered simultaneously to the final damage figures and the final atlas.

The report should consist of the following chapters:

- the methodology used for damage assessment using remote sensing,
- the input resources: remote sensing data, census-data, baseline maps and datasets, etc.
- the validation and QC methods including the field surveys
- the modeling tools and approaches,
- the aggregation methods implemented,
- the final results including the raw outputs and the analytical products,
- the limitations of the products and
- Statements on liability and dissemination constraints.

The report should be submitted to the PDNA coordinator for its inclusion as an annex to the final PDNA report.

Internal and external communication

Effective communication, both internal and external, is a key component for the CoSA effort. It goes without saying that internal communications are essential to manage and coordinate the CoSA activities, but external communications are equally important to create trust and reinforce the perception of a successful effort.

Internal communication should start as soon as a disaster strikes. During the Pre-PDNA phase, each CoSA team will designate a coordinator responsible for inter-team communication. The designated coordinators will agree together on the triggering of the CoSA process and accordingly will assign the different roles. They will identify the existing resources (including products), critical reference data sets and the need for imagery purchase and establish the plan for the CoSA process based on the current SOP. The list of key persons to be involved in the CoSA will be established, the timing for the scoping mission will be decided and the expected deliverables will be agreed at this stage. During the PDNA phase, the internal communication will be managed by the CoSA coordinator who will ensure the circulation of information between the different teams. Internal communication should first start with phone meetings and then continue with video conferencing tools (e.g. WebEx, Skype, Eyejot, etc.). A dedicated collaborative site or central repository with chat functions can be developed for data and information sharing.

As for the external communication: during the PDNA timeframe, the CoSA country focal point will ensure a continuous communication with the different PDNA cluster/sector leaders. He/she will attend the meetings of the various clusters, report to the CoSA coordinator on specific sector needs and update the clusters on the CoSA work progress and ensure the proper distribution of the intermediate deliverables. The CoSA **coordinator** in turn will ensure two-way communication with the PDNA coordinator. CoSA coordinator’s responsiblity will include the dissemination of the intermediate results and the provision of existing and customized mapping products to the scoping mission. The main role of CoSA coordinator in terms of external communication is to ensure the handover of the data and results to national entities.

Lessons learned seminars and SOP review

Following each CoSA, seminars dedicated to the lessons learned should be organized with the purpose of sharing the experiences between the different teams, identification of technical/communication problems faced during the CoSA, identification of errors to be avoided for future collaborative efforts and mainly for proposing amendments, if necessary, or improvements to the current SOP.

The current SOP is a living document that needs to be revised following practical experiences of CoSA. It should be circulated to the different teams for their inputs and revised at least once per year. Examples related to previous CoSAs can be added to strengthen the theoretical section. Technical annexes pertaining to : i) the methodology for damage assessment, ii) the field forms, iii) the quality control and validation protocols iv) to the data integrity check and SDI management v) to practical examples of CoSAs (e.g. Haiti, Pakistan) should be added as annexes to new versions of the SOP.

A designated author will be responsible for the implementation of permanent modifications. The amended SOP will be then circulated for review and approval by the different teams. Documentation of annual SOP review will be maintained in the SOP archives.

The SOP needs to be tested prior to its application in real disaster events. A case exercise has to be defined after consultation with the different partners. The case study should enable a simulation of the CoSA process.

Post-PDNA dissemination

The outputs of the CoSA have a broader scope than the final PDNA report. They can serve a number of applications related to disaster management and risk reduction:

- the atlas of urban settlements can be used to update the exposure database and to improve the vulnerability functions
- the updated information on building density can help to improve the early warning systems
- better and up to date fundamental data on housing infrastructure in conjunction with other geospatial data on population density and land-use information can help improving vulnerability analysis
- the developed SDI (i.e. GeoNode, http://geonode.org) can be used to improve mitigation measures thanks to a better understanding of the underlying causes of disasters and their socio-economic impacts
- the detailed damage assessment is essential for early recovery planning (e.g. prioritizing buildings for rapid rehabilitation, shelter, water, sanitation, logistics)
- during the rehabilitation phase, the damage assessment can be used for debris management and city planning (i.e. input to cadastral planning)

In addition to these applications, the results of the CoSA can be used within scientific studies:

- the validated building damage assessment can be used for the calibration of damage and loss models
- the detailed digital elevation model can be employed for multi-hazard modeling (floods, landslides, etc.)
- the field data collected during the CoSA can be used to improve the sampling procedures and stochastic damage assessment models.

The dissemination of the CoSA results during the post-PDNA phase and the hand-over of the SDI to national authorities should be used as tools for improving external communication, for raising awareness and for fund raising. Potential future PDNA in the same country can benefit from the existent SDI and the updated baseline information. Finally, the results of the CoSA will aim at strengthening the local capacities for the management of disasters.

10. Records management (CoSA coordinator + team leaders)

The success of a CoSA lies in an effectively managed and properly planned internal information system. Information has most value when it is accurate, up to date and accessible when it is needed by the different teams involved in the CoSA. An effective records management for the activities of the CoSA can be achieved through the use of:

- a common SDI repository including common standards, policies and access rules. The SDI should be subject to restricted access for external users (who are not part of the CoSA staff) like local counterparts and PDNA actors.
- a common document repository
- a common logbook/journal for recording daily tasks
- an appropriate training of all staff so that they would become fully aware of their personal responsibilities in respect of record keeping and management and that they are competent to carry out their designated duties. This should be done through both generic and specific training of the staff completed by organizational policies and guidance documentation.

Record keeping/journaling

Records need to be updated and maintained before, after and especially during operations in order to learn and improve the procedures of the internal team and between partners during an event. By journaling relevant aspect of operations, the logs can be input to periodical exercises and lessons learned practices afterwards. It might also form a basis for reproduction of events for tracing back/reconstruct the order of events when requested (in legal issues, for means of publications):
It is important to record the relevant aspects using specific logging standards (either imposed by IT/software or by international standards e.g. ISO procedures in the end) into common repositories

using unique attributes linked all together with specific key attributes (especially time and place) (Van Leeuwen, 2010).

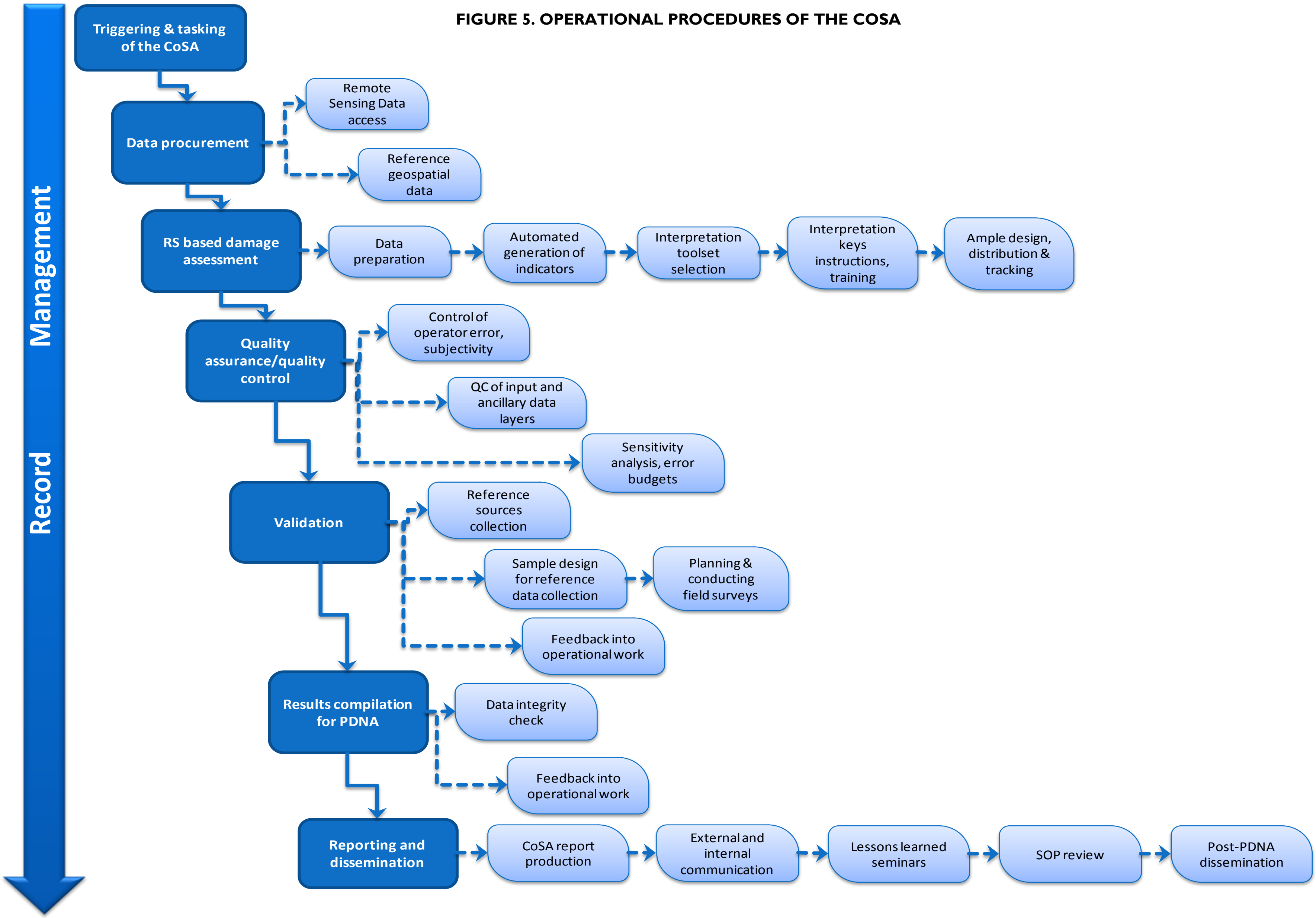
Relevant issues to record (with time & place tags):

1. internal activities (actions linked to internal decisions, persons, meetings, etc.)
2. external activities (actions linked to partners or beneficiary org. or else)
3. communications/messaging inside and outside (with all relevant attributes)
4. data & information flows , meta-information
5. internal products (versioning, see also e.g. validation and quality control)
6. external products (versioning and see also reporting and dissemination section above)
7. all issues need to be tagged in terms of accessibility (rules who can see what)

Implementing and maintaining an effective records management depends on knowledge of what records are held, where they are stored, who manages them, in what format(s) they are made accessible, and their relationship to organizational functions. An information survey or record audit is essential to meeting this requirement. The CoSA data manager will be responsible for auditing all aspects related to records management. A wiki (http://wiki.drrlabs.org/groups/crsda/) has already been setup for the internal communication and documents management and sharing between the CoSA partners. It is a simple online database that can be used as internal documentation for records keeping and as a collaboration tool between the different actors involved in the CoSA.

The operational procedures of the CoSA are summarized in the following flowchart (Figure 5).

FIGURE 5. OPERATIONAL PROCEDURES OF THE COSA



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Abstract

The purpose of this Standard Operating Procedure (SOP) is to establish uniform procedures pertaining to the preparation for, the performance of, and the reporting of **CO**llaborative (geo) **S**patial **A**ssessment (CoSA).

CoSA provides a synoptic, unbiased assessment over the impact area of a disaster, which feeds the two main recovery perspectives of the Post-Disaster Needs Assessment (PDNA): i) the valuation of damages and losses carried out through the Damage and Loss Assessment (DaLA) methodology; and ii) the identification of human impacts and recovery needs carried out though the Human Recovery Needs Assessment (HRNA). CoSA is distinct from other geospatial and remote sensing based assessments because it i) draws on the collaborative efforts of distributed capacities in remote sensing and geospatial analysis, ii) aims to achieve the highest possible accuracy in line with the requirements of the PDNA and iii) tries to do so under stringent timing constraints set by the PDNA schedule. The current SOP will aid in ensuring credibility, consistency, transparency, accuracy and completeness of the CoSA. It is a living document, however, that will be enriched with new practical experiences and regularly updated to incorporate state-of-the-art procedures and new technical developments.

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