Damage Assessment Coordination Centre (DACC) Handover Document - Les Cayes, Haiti

Executive Summary

The M7.2 Haiti Earthquake which occurred on 14th August, resulted in many buildings being severely damaged, including health facilities, hurricane shelters, schools and other facilities critical to the recovery. This Handover Document outlines a proposal for successful operations of the Haitian-led Damage Assessment Coordination Centre (DACC) in Les Cayes, Haiti. The proposal is the outcome of several workshops with key stakeholders, at the regional and national levels, and documents the process that was agreed to continue after SARAID's departure.

SARAID gratefully acknowledges the excellent collaboration with colleagues from the Swiss Embassy, and EU Civil Protection Mechanism, without whom this work could not have been as successful. Particular thanks to the Engineers of the Swiss Embassy, who have been able to remain in-country after SARAID's demobilization to continue the work that we began together. We also warmly thank IOM for their support in Les Cayes, and for arranging the various workshops with key stakeholders, to define the details of this Handover Document.

Here, DACC refers to the physical space operated jointly by national (e.g. MTPTC) and international (e.g. IOM) partners to manage assessments by both national and international Structural Engineers. This proposal is provided by SARAID-UK, to the lead operators of the DACC, primarily the Ministry of Public Works, Transport and Communication (MTPTC), UNOPS and IOM. This Handover Document focuses on rapid safety assessments of buildings of key public interest, such as hospitals, schools, hurricane shelters, etc.

The proposed DACC activities are separate from, but complimentary to, a full area-wide damage assessment of all affected buildings, planned for the coming months by The World Bank, UNOPS, Miyamoto International, and other partners. The intention of the DACC-operated rapid safety assessments is not to divert resources from the full area-wide damage assessment, but instead in the interim whilst the wider assessments are being designed, to:

- Protect people from unsafe buildings;
- Enable reopening of critical buildings that have not been significantly damaged, allowing access to essential facilities critical to the recovery.

Both objectives above are crucial for rapid recovery following the earthquake. The recommendations of this Handover Document are specific to the Province of Sud, but could also be applied in other Provinces of Haiti.

The proposed DACC operations are formed around 4 components, outlined in Table 1 below**.** This document expands on each of these four components.

rob.davis@saraid.org.uk

	Component	Objective
1	Procedural/Legal Framework	Official system of working including: assessing, evacuating, making-safe of buildings
2	Coordination of Assessors	Efficient operational organization of damage assessors
3	Technical Building Assessment	A consistent method to decide: evacuate / don't evacuate
4	Data Management	Efficient system for central storage, analysis and reporting of damage data

Table 1: Key Components of a Damage Assessment Coordination system

The information provided within this Handover Document is presented as expert advice. The decisions and responsibilities associated with defining and implementing a coordination system for Damage Assessments by local assessors, remains wholly with the Authorities of Haiti. If any portion of this document is to be adopted in Haitian procedures, then it is recommended that the relevant sections are translated into French and/or Haitian Creole.

The operations and procedures presented in this Handover Document build on the systems already in place in Haiti (e.g. the assessment form proposed by the Ministry of Public Works, MTPTC). The DACC advise is based on lessons learnt following:

- The Albania earthquake of November 2019, where the DACC was jointly operated (at that time) by EUCP, UNDAC, OFDA [link]
- The Beirut of port explosion of August 2020, where SAIRAID-UK set-up and run a DACC to support the Municipality of Beirut and Lebanese Armed Forces [link]

This Handover Document forms one of 2 objectives of the SARAID deployment: (1) to support establishment of a damage assessment coordination process in Haiti (as outlined in this Handover Document), and (2) to directly assess critical buildings in the interim whilst a DACC is being established (as defined in a separate document "*Summary of Advisory Building Safety Assessments by International Engineers Following the Aug 14 M7.2 Haiti Earthquake*")

rob.davis@saraid.org.uk

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rob.davis@saraid.org.uk

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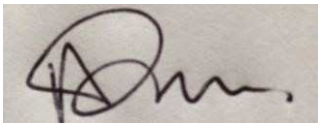
	Description	Date	Lead Author	Approved By
-	Initial Draft	28 Aug 20201	Josh Macabuag	Rob Davis

Signatures



Rob Davis **MSc FIFireE**
Team Leader
International Response Team Trustee
Search & Rescue Assistance in Disasters
UK Registered Charity No.1101593

Josh Macabuag **CEng MICE PhD**
Engineering Manager
Search & Rescue Assistance in Disasters

Suzie Cooper **BSc, MSc**
USAR Engineer
Search & Rescue Assistance in Disasters

With thanks to all the SARAID team members (in Haiti and the UK) that made this work possible, and the excellent colleagues from the EU Civil Protection Mechanism, and the Swiss Embassy.

rob.davis@saraid.org.uk

Glossary

CEng	Chartered Engineer (UK)
DACC	Damage Assessment Coordination Centre
EUCPT	European Union Civil Protection Team
EST	Engineering Support Team
EVOLSAR	European Association of Civil Protection Volunteer Teams
IEC	INSARAG External Classification
MICE	Member of Institute of Civil Engineers
NGO	Non Government Organisation
SARAID	Search and Rescue Assistance in Disasters
SDAT	Structural Damage Assessment Team
SOP	Standard Operating Procedure
TL	Team Leader
EUCPT	EU Civil Protection Team
DPC	Direction de la Protection Civile (Civil Protection Directorate, Haiti)
UNOPS	United Nations Office for Project Services
MTPTC	Ministère des Travaux Publics, Transports et Communications (Ministry of Public Works, Transport, and Communications)
COUD	Departmental Emergency Operations Centre (COUD)
IOM	International Office for Migration
OSOCC	On-Site Operations Coordination Centre
OFDA	Office of Foreign Disaster Assistance (USA)
UNDAC	United Nations Disaster Assessment and Coordination
UKIVRA	UK International Voluntary Rescue Alliance
UN OCHA	United Nations Office for the Coordination of Humanitarian Affairs
UN INSARAG	United Nations International Search and Rescue Advisory Group
USAR	Urban Search and Rescue

rob.davis@saraid.org.uk

1. Introduction

On 14th August 2021, a M7.2 earthquake hit the Suds region in Haiti. In the aftermath, the DPC reported 2,207 people dead, at least 344 missing, over 12,000 injured and upwards of 130,000 homes damaged or destroyed. The most affected areas were Sud, Grand'Anse and Nippes.

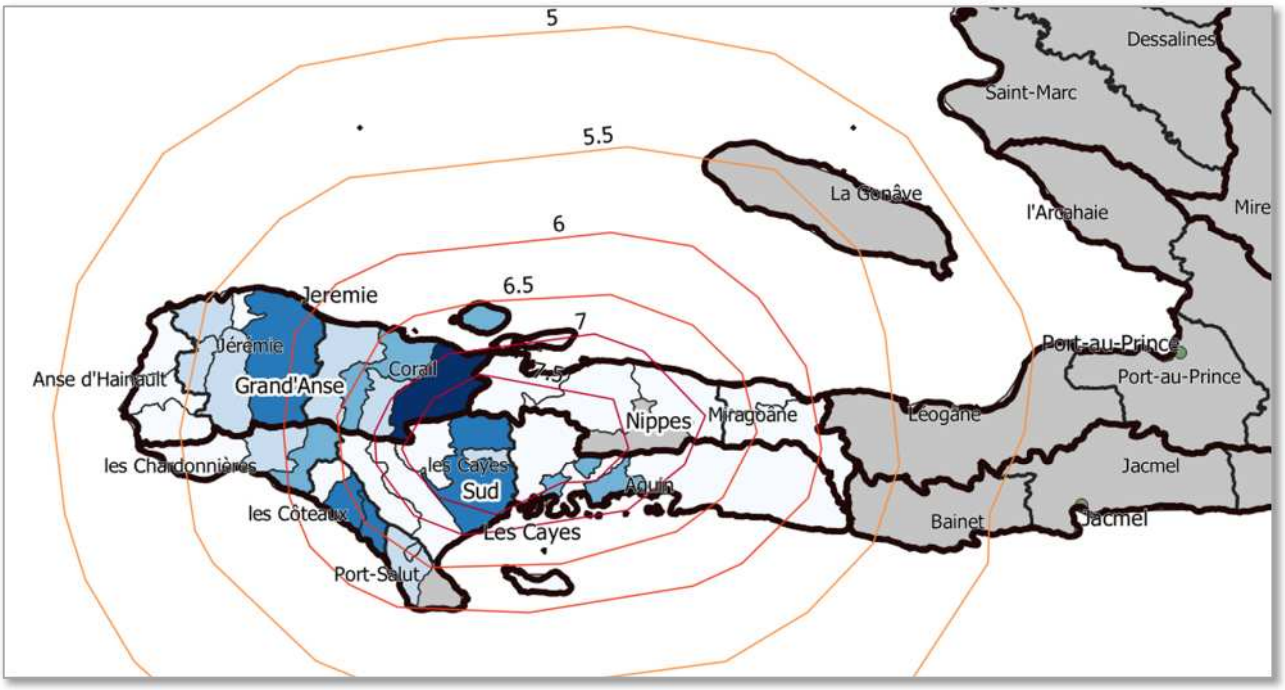


Figure 1: Map of affected region. Colours indicate the number of damaged buildings as reported by DGPC as of 19th August. Contours indicate ground-shaking intensity as reported by USGS.

1.1. About the Authors

SARAID (Search and Rescue Assistance in Disasters) is a UK-based USAR NGO, registered with UN INSARAG as a Light USAR Team (IEC pending). SARAID is a member of EVOLSAR and UKIVRA and has over 20 years' experience in deploying to major disasters internationally. Some of our members have also previously deployed as EUCPT Experts in a damage assessment coordination capacity.

SARAID's International Response Team (IRT) has several operational professionally qualified structural and civil engineers, who are able to deploy as part of a USAR team or independently as a Structural Damage Assessment Team (SDAT). This team would then be supported in the field remotely by our UK-based Engineering Support Team (EST).

SARAID's IRT members are also trained in the UN OCHA OSOCC methodology and system.

rob.davis@saraid.org.uk

1.2. Setup of the Damage Assessment Coordination Centre (19th – 25th Aug)

19th August

Following the earthquake SARAID initially deployed a six-person SDAT to Haiti, with this team landing in country on 19th August 2021. This was on the request of the Haitian Ambassador in the UK (His Excellency M.Euvrard Saint Amand). On 19th August the Director General of the Directorate of Civil Protection, Dr Jerry Chandler, requested SARAID to deploy to the affected region of Les Cayes to facilitate safety assessments of critical buildings such as hospitals, schools, hurricane shelters etc. In response, SARAID set out with 2 objectives:

1) Initiate the Damage Assessment Coordination Centre (DACC), to coordinate Haitian assessors to conduct building safety assessments of critical buildings. This was to meet the immediate recovery needs of the affected communities, whilst longer-term plans were made for area-wide assessments supported by the World Bank and UNOPS.
2) Directly assess buildings of public interest (primarily hospitals and schools), to protect people from unsafe buildings and speed the reestablishment of facilities critical to the recovery.

The result of Objective 1 is covered in this report. Objective 2 is covered in a separate report "*Summary of Advisory Building Safety Assessments by International Engineers Following the August 14th M7.2 Haiti Earthquake*".

22nd August

Regarding the DACC: SARAID along with 2 additional engineers from EUCPT, **deployed to Les Cayes on 21st August 2021, held a meeting together with Engineers from Swiss Embassy on 22nd August** (Figure 2), to outline a proposal for forming a DACC. Later that day SARAID and Swiss Embassy formed an initial proposal for changes to the MTPTC assessment form to bring it inline with other international standards.

Figure 2: Initial meeting between SARAID, Swiss Embassy and EUCP to discuss formation of a DACC.

rob.davis@saraid.org.uk

23rd August

On 23rd August SARAID presented to an IOM-organised workshop at the Les Cayes Regional Emergency Operations Centre (COUD), to present the proposed DACC organisational structure and ask participants for their inputs. The workshop was attended by MTPTC, UCLBP, the Mayor of Les Cayes, DPC, Habitat for Humanity. **The proposal presented in this document is the outcome of this workshop.**

Figure 3: Workshop lead by SARAID and Swiss Embassy to agree the preferred Damage Assessment Coordination process, and discuss the proposed changes to the MTPTC Assessment Form.

24th August

On 24th August, SARAID, EUCPT and Swiss Embassy began setting up the DACC along with IOM and MTPTC local engineers. The agreed components were discussed (more details on each are found in section 2) with tasks set to key stakeholders that progressed the formation of the DACC. It was agreed that:

- Contact list of assessors – IOM, MTPTC and Habitat for Humanity all offered a number of local, licensed engineers who would be on hand to conduct these assessments. IOM were to collate a list of all assessors.
- The coordination process of these assessors was discussed and training for them was agreed.
- Posting system – A marking system that is directly applied using spray paint was agreed.
- The process for restricting access to parts of a building defined as Yellow was agreed.
- The occupants shall be informed about the assessment outcome by the assessors and contact details provided to them so they can gain further information.
- OSOCC would provide a physical space for the coordination process to take place.
- Communes are to be used as sectors.
- MTPTC is to coordinate with the various government departments to compile a list of priority buildings (for examples the Ministry of Education will define all schools, colleges and universities that should be assessed).
- Roles and responsibilities were assigned.

All of the above feed into the 4 components of the DACC process as defined in Table 1

rob.davis@saraid.org.uk

25th August

On 25th August, key stakeholders in damage assessment met with MTPTC assessments director, Raymond Hygin (Figure 4). The DACC proposal was discussed in the context of the full area-wide damage assessment to be lead by MTPTC, UNOPS and IOM. Full minutes of this meeting are provided in the Annex. It was agreed that:

- Director Raymond Hygin (MTPTC) suggested 2 separate stages of structural assessments, both to be lead by MTPTC:
    1. Rapid Safety Assessments of critical buildings (hospitals, schools, churches, hurricane shelters, etc) in urban/accessible areas.
    2. Comprehensive Assessments of the entire affected region, including residential buildings.
- Rapid Safety Assessments are to begin as soon as possible.
    - The objective is to provide decisions on whether critical buildings should be evacuated (red-tagged), have use-restrictions (yellow-tagged), or if the earthquake has not reduced the capacity of the structure (green-tagged).
    - The MTPTC Form is to be adopted, with minor suggested amendments as proposed by Swiss Embassy and further amendments discussed during the meeting.
    - International Engineers (SARAID-UK, Swiss Embassy, EUCPT) have been working in Les Cayes for the past days to support the local agencies prepare to begin MTPTC-led damage-assessments, once central approval is received. This is in response to a request made to SARAID-UK by Director General of the Directorate of Civil Protection, Dr Jerry Chandler, to assist damage assessment in the region.
    - Assessments are to be conducted asap to take advantage of the presence of international Engineers, who are only in country for the next few days.
    - Training is to be conducted by Engineers of the Swiss Embassy and EUCP in Les Cayes, on Friday morning. Assessments can begin thereafter.
- In parallel, preparations for long-term, Comprehensive Assessments of the entire affected region are to take place.
    - This work is led by UNOPS and Miyamoto International, and will begin once preparations are complete, expected to be a few weeks.

Figure 4: MTPTC workshop to discuss how the proposed DACC assessments of critical buildings can fit together with the full area-wide assessments to be lead by UNOPS.

rob.davis@saraid.org.uk

1.3. Overview of DACC

The remainder of this report provides details/recommendations of the DACC process, as agreed with the various parties of the workshops described above. The DACC process is outlined according to the 4 components provided in Table 1, with a section of this report dedicated to each component:

1. Procedural/Legal Framework
2. Coordination of Assessors
3. Technical Building Assessment
4. Data Management

rob.davis@saraid.org.uk

2. DACC Proposal

2.1. Procedural and Legal Framework

Objectives

The Objectives of the DACC in Haiti is to coordinate national and international engineers, to assess critical buildings of public interest, such as hospitals, schools and hurricane shelters. It is expected that the majority of assessors will be national (Haitian) Engineers, and it is not expected that many international Engineers will be available at this time.

The aim of defining a clear procedural and legal framework, is to put in place an official system of working for: assessing, evacuating, and making-safe the buildings. If this is not done efficiently, then the outcome of the assessments will not be quickly enforced and people may remain in a dangerous building, even after an assessment has been made.

Note that if there is a possibility of trapped victims inside a structure, then a Search & Rescue assessment should be made. This would generally not be conducted by the structural assessors (unless specifically trained to do so, e.g. USAR engineers), but would require notifying the appropriate authorities (e.g. military, or USAR coordination) that a further search for victims is required. Potential for Assessment Search and Rescue (ASR) to be undertaken and reported to USAR coordination through Civil Protection, Haiti.

The DACC process builds on existing Haitian procedures and considerable in-country expertise. Additional guidance is provided drawing from experience of international disasters and international standards (such as FEMA P-2055[1]). All recommendations are the result of agreement with key stakeholders at the workshops described in section 1.2.

Governance Structure

The DACC is to be operated jointly by MTCPT and IOM. MTCPT is the national body responsible for all structural assessments in the country, lead by Director Raymond Hygin.

Note that this setup is different to the DACCs in Albania and Beirut, as these were run by international organisations (Beirut DACC was run by SARAID, Albania DACC was run by UNDAC, EUCPT, OFDA) and had the objectives to: support the government setup its own system of damage assessment, and to coordinate international assessors to aid the efforts. In Haiti however, there are far fewer international engineers available, so the focus is on a Haitian-led DACC focussing on coordinating Haitian assessors.

The DACC has been provided with a physical space in the Les Cayes OSOCC. The OSOCC has a finite lifespan that may be shorter than the DACC, so the DACC may need to relocate at a later date.

The DACC in Relation to Other Assessments Underway

The DACC is one of several building assessments underway in Haiti.

The DACC does not conduct wider needs assessments[2], but instead focuses on building safety assessments by Structural Engineers or other suitably qualified assessors.

The DACC assessments can be thought of as the 2nd step in a 3-step process:

[1] *FEMA Post-disaster Building Safety Evaluation Guidance P-2055 (Nov 2019)*

[2] Many of the wider needs assessments can be found on ReliefWeb: https://reliefweb.int/disaster/eq-2021-000116-hti

rob.davis@saraid.org.uk

1. **Count/Estimate of Damaged and Destroyed Buildings**. This has been completed by DGPC in the initial days after the disaster, to provide broad estimates of damage as shown in Figure 5.
2. **DACC: Building Safety Assessments of critical buildings (hospitals, schools, hurricane shelters, etc).** These assessments are conducted with urgency to evacuate people from unsafe buildings, or to expedite the reopening of key buildings that are suitable for continued use. A further reason for the urgency of these assessments, is to make use of the international resources in-country. Note that these are structural assessments, and additional considerations may be required for reestablishment of some services (e.g. WASH)
3. **Wide-area assessment buildings, and additional impacts.** A more comprehensive assessment of all affected buildings, including residential, is to be conducted by MTPTC and UNOPS, funded by e.g. The World Bank, in support of a Post-Disaster Needs Assessment. These assessments are still being designed at the time of writing, expected to begin in a few weeks, and to last a few months. Hence the DACC process being initiated in the interim, to meet the immediate life-safety and recovery needs, and to make use of in-country international resources.

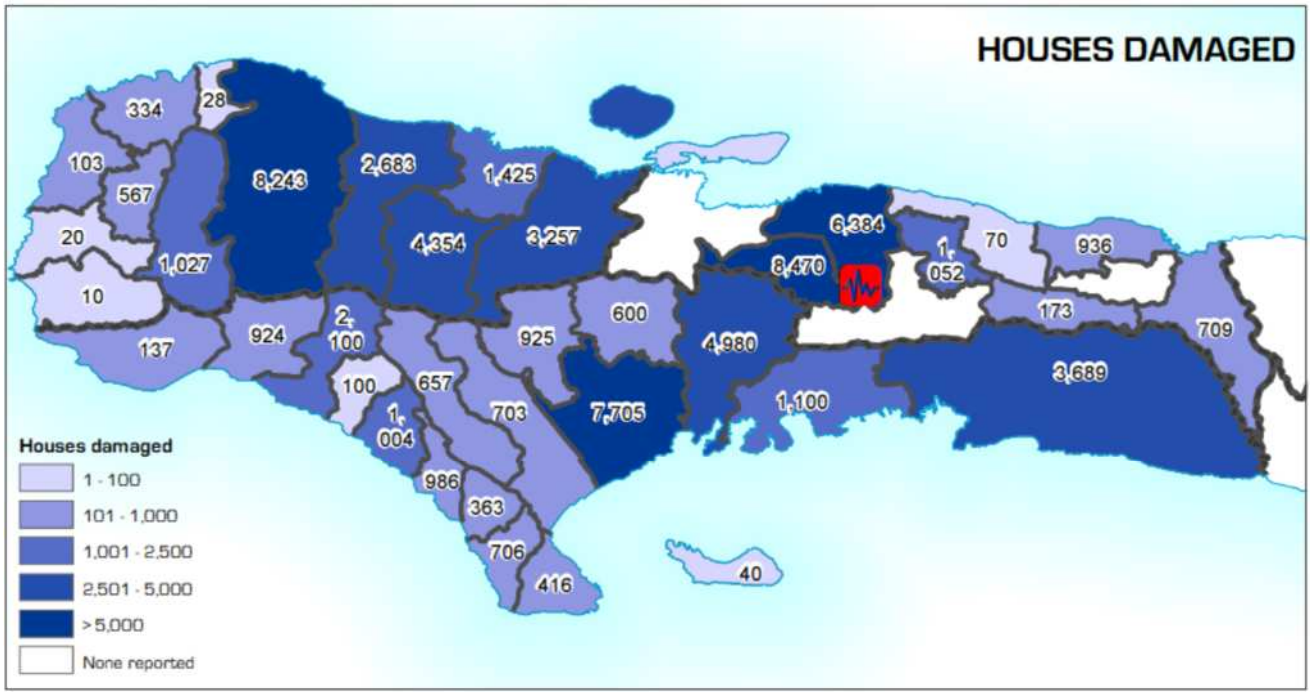


Figure 5: Estimates of the total numbers of damaged houses, as reported by DGPC (image from MapAction 27th Aug). This is step 1 of the 3-step process described above, and occurred before establishment of the DACC.

Posting System

It is vitally important that the result of each assessment is clearly marked on the building. This is to protect those in and around the building from potentially unsafe situations.

After undergoing safety assessment, buildings are marked with one of three colours:

- **Green: INSPECTED**
- **Yellow: RESTRICTED USE**
- **Red: UNSAFE**

These markings let owners, occupants, and the public know whether inspected buildings are safe for use. The assessor determines the posting category based on the perceived degree of risk to the occupant as per the process encapsulated in the amended assessment form (Section 2.3).

rob.davis@saraid.org.uk

Markings applied directly to the building are preferred to placards, for fear of placards being removed or vandalized. This is as per discussion with key stakeholders during the workshop on 23rd August (section 1.2, Figure 3).

Markings may be applied by the MTPTC assessors directly. This is as per discussion with key stakeholders during the workshop on 23rd August (section 1.2, Figure 3), where it was decided that security concerns were not sufficient to make such an approach unsafe.

Restricting Access

In addition to posting a building, it may be necessary to define areas for which access is restricted. These can be hazardous areas inside or outside the building. For example, if a badly cracked parapet is observed, the area on the ground outside the building and within possible striking distance must be barricaded to prevent entry. If necessary, the building may be marked with the appropriate colour, and any safety measures (e.g. barrier tape) should be put in place by the assessors.

Informing Occupants of Assessment Decisions

Assessors are to inform occupants directly of their assessment decision. This is to ensure that the occupants understand the reason for any decision and, crucially, any restrictions that are recommended as these must be adhered to for their safety.

Assessors are to additionally leave 1 of 3 pre-written letters (corresponding to the assessment decision), explaining the implication for the assessment, and providing a phone number that the occupant may contact for further information, or to dispute the decision.

Assessor Qualifications

Personnel engaged on damage assessment should be able to provide evidence of relevant educational and/or professional experience. They should preferably have certification/documentation relating to their qualifications, professional affiliations and/or experience in relevant positions of responsibility.

Haitian assessors are required to be licensed Engineers. This is as per discussion with key stakeholders during the workshop on 23rd August (section 1.2, Figure 3), where it was felt there were a sufficient number of licensed Engineers available such that this would not prove an overly restrictive requirement.

The Role of International Engineers

International Engineers do not work without a local Engineer counterpart, and International engineers never complete or sign paperwork. International Engineers are to follow the agreed procedure to *assist* local engineers in assessing damage. It is the responsibility of the local engineer to sign all paperwork and complete all forms.

rob.davis@saraid.org.uk

International Engineers should focus on critical life-safety buildings. International engineers will only be in country for a relatively short time, so it is not the goal to use International Engineers for every building, but instead to first focus on those that may pose a risk to life.

International Engineers are not to advise on demolition nor advise on reconstruction methods, unless specifically qualified to do so.

Scope of the Assessments

This proposal focuses on typical building structures. Specialised structures, such as non-building infrastructure (e.g. bridges, roads, etc) and industrial facilities (e.g. refineries, ports, power plants) are beyond the scope of this proposal as they need special treatment and specialised resources.

Assessors conduct reviews of damaged, or potentially damaged, buildings to evaluate safety and habitability. Their role does not extend to considerations of demolition and/or repair.

Not Included in this Proposal

This proposal includes logistical, organisational and practical recommendations for the damage assessment coordination system but focuses specifically on the on-site procedures, and decisioncriteria associated with assessing physical damage to buildings and deciding whether occupants must be evacuated.

The following considerations are not included in this proposal:

- **Assessors' objectivity**: It is preferable that the assessors and the occupants are not known to each other, as this can influence results (e.g. increasing the recorded damage to allow more compensation). This can be combatted by, for example, using assessors from areas that are sufficiently far away from the area they are assessing.
- **Assessing loss to contents**: Guidelines on assessing damage to building contents are not included in this proposal.
- **Specialist structures**: Power stations, sea defences, large bridges and dams are all examples of structures which are not included in this proposal. These structures should be assessed by engineers with specialist knowledge and experience with that type of structure.
- **Quantifying the *cost* of damages**: One output of a Damage Assessment is that it may be used to calculate the associated financial costs. However, the procedure for calculating costs from the damage is not covered in this proposal.
- **Method of financial compensation**: One output of a Damage Assessment is to enable the affected families to receive compensation or assistance. The calculation of the compensation, and delivery of that compensation (e.g. as money paid directly to the occupants or paid to contractors who manage repairs) are decisions which must be taken by the relevant Haitian authorities, in accordance with Haitian law. These considerations are not included in this proposal.
- **Propping and shoring of structures**: The responsibility of stabilizing damaged structures should generally be the responsibility of the Local Authorities (with the exception of USAR operations for live rescues, in which case shoring by USAR teams may be acceptable/necessary). Stabilization of damaged structures is not the immediate responsibility of the damage assessors, and so is not included in this proposal.

rob.davis@saraid.org.uk

- **Provision of sufficient engineering capacity to conduct assessments**: Some municipalities may not have access to enough qualified engineers to conduct Damage Assessments rapidly. Systems for training, registering and deploying pools of qualified engineers for these situations is not considered in this proposal.

2.2. Coordination of Assessors

The coordination of assessors is the vital first component for the establishment of a successful Haitian-led Damage Assessment Coordination system. The objective is to implement efficient operational organization of the damage assessors to ensure assessments are made in a timely, structured manner.

Coordination Procedure

In order to achieve this, it is recommended that the Haitian Authorities conduct the following steps to ensure effective coordination of the Haitian assessors:

- Identify and list available engineers / damage assessors with a record of their qualifications
- Confirm list of sectors and their priority rating
- Identify any priority buildings within each sector (if known)
- Ensure one municipal engineer takes overall responsibility for each sector (for the duration of the assessments)
- Allocate teams of assessors to the same sectors on a daily basis until complete to ensure continuity and consistency.
- Ensure assessors are aware of the process and expectations of them (see briefings below)
- Assessors are to report back periodically

Note that the term 'sector' above and throughout this section refers to Communes in Haiti. 'Sector' is a general term that refers to an agreed area of operation, and it was agreed during the workshops described in Section 1.2, that Communes would be the most appropriate administrative boundary for damage assessments in Haiti.

If international teams or engineers are available to support, they should always be paired with Haitian assessors and should not undertake any assessments individually.

The progress should be tracked and assessed daily to ensure there is no duplication or gaps in the coverage of the sectors.

Briefings

A key task when coordinating the assessors is to ensure they are aware of the process and expectations of them. A good way to do this is to provide briefings for any new assessors (Haitian or International) to outline the methodology and answer any questions they may have. These briefings may include, but are not limited to the following:

- The background (why the Damage Assessment Coordination system was set up, and what is expected of assessors)
- The taskings (where the assessors are to assess, and how future taskings will be communicated)
- The procedure for assessment (see section 2)
- How to use KOBO
- The technical assessment process on-site (see section 3)

rob.davis@saraid.org.uk

- Reporting their findings

It is also important to reiterate that the Damage Assessment Coordination system is a Haitian-led assessment, supported where available by international engineers. Any international expertise should be focused on supporting Haiti in the following two areas:

1. Important life-safety buildings and infrastructure
2. Knowledge-sharing with the Haitian engineers, so that they can complete the job themselves once the life-safety buildings are dealt with.

rob.davis@saraid.org.uk

2.3. Technical Building Assessment

The aim of clearly defining the method of technical building assessment, is to ensure a consistent method of deciding whether a building should be evacuated or not. A suitable form (paper or digital) is required, as well as instructions and training on how to use it, so that all assessors are operating in the same way and making consistent decisions.

This section builds on the existing MTPCT Damage Assessment form, and provides step-by-step guidelines for conducting assessments, classifying damage, and deciding whether a building should be evacuated. This is following field-observations in several disasters around the World, that there were some inconsistencies in the ways that different assessors were conducting their assessments, and also as per discussion with key stakeholders during the workshop on 23rd August (section 1.2, Figure 3).

The MTPTC Municipality Building Damage Assessment Kobo form with some minor recommended changes and a short Guidance Note summarizing the information of this section, is provided in Annexes 3 and 4.

If all assessors across all Provinces follow the same Damage Assessment procedure, then Damage Assessment results can be accurately aggregated at the national level for planning, and international assistance and financing. Therefore, the forms and step-by-step guidelines provided in this document are provided to allow Haiti to respond effectively and consistently across the country in this and future disasters.

To ensure the Haitian Damage Assessments can meet international standards necessary for national-level planning, international assistance and financial assistance, the main recommendation are as follows:

- **Haitian building Damage Assessments should be conducted consistently** across all teams, jurisdictions, and organisations according to a national methodology.
- **Written guidance and training should be made available for assessors**, so that all assessors across the country can work according to the same procedure and make decisions on damage and habitability classification according to a consistent set of criteria.

Methods presented in this section are based on the MTPTC Municipality Building Damage Assessment Kobo form (shown in Annex 1). Additional information is also provided from internationally recognised standards: ATC-20[3] and Greek standards[3].

Note that if there is a possibility of trapped victims inside a structure, then a Search & Rescue assessment should be made. This would generally not be conducted by the structural assessors (unless specifically trained to do so, e.g. USAR engineers), but would require notifying the appropriate authorities (e.g. military, or USAR coordination) that a further search for victims is required.

The following text is adapted from ATC-20.

The overall objective of each assessment is to assess whether a building should be evacuated (Unsafe), should have safety measures put in place (Restricted Use), or if the earthquake has not

[3] *Engineer's Manual*, Greek General Directorate for the Rehabilitation of the Impacts from Natural Disasters (DAEFK). Greek Name: Γ.Δ.Α.Ε.Φ.Κ. (Γενική Διεύθυνση Αποκατάστασης Επιπτώσεων Φυσικών Καταστροφών)

rob.davis@saraid.org.uk

significantly reduced the load-bearing capacity of the structure (Inspected). It is performed by evaluating a building relative to basic criteria, which are listed in Table 4, but with additional checks/criteria provided in the assessment kobo form to provide additional guidance related to the final assessment decision. The method, which relies on visual observations by structural engineers, is intended to provide reasonable assurance that a building, although damaged, is sufficiently safe to use, or alternately that part or all of the building must be restricted because of safety concerns.

Condition	Action [1]
1. Building has collapsed, partially collapsed, or moved off its foundation.	Post UNSAFE.
2. Building or any story is significantly out of plumb (i.e., leaning).	Post UNSAFE.
3. Obvious severe damage to primary structural members, severe racking of walls, or other signs of severe damage and distress present.	Post UNSAFE.
4. Obvious parapet, chimney, or other falling hazard present.	Post RESTRICTED USE and barricade the unsafe area.
5. Large fissures in ground, massive ground movement, or slope displacement is present.	Post UNSAFE.
6. Other hazard present (e.g., toxic spill, asbestos contamination, broken gas line, fallen power line).	Post UNSAFE and/or barricade unsafe area [2].

Table 4: ATC-20-1[4] Rapid Evaluation Criteria. This is quick initial guidance only and additional checks/criteria provided in the assessment kobo form to provide additional guidance related to the final assessment decision.

When there is uncertainty about posting a structure Unsafe, consider posting it Restricted Use (with appropriate restrictions indicated) and request a further assessment. Buildings with moderate damage can be difficult to evaluate. In doubtful situations, the use of judgment is required. If a building is found to have none of the conditions listed in Table 4, and if there are no other hazards or unsafe conditions present, it is apparently safe and can be posted Inspected.

Because the Assessment method is designed to quickly find serious damage and to conserve limited personnel resources in the immediate post-event period, the safety evaluations are generally limited and brief. Assessors are to look for readily observable, gross kinds of structural damage and distress, hazardous geotechnical conditions (e.g. landslide), and other hazards that threaten building safety. The step-by-step inspection procedure is summarized in Table *5*.

rob.davis@saraid.org.uk

1	Examine the entire outside of the structure.
2	Examine the ground and pavement in the general area of the structure for fissures, bulged ground, or signs of slope movement.
3	Enter a building when the structure cannot be viewed sufficiently from the outside and when there is a suspected or reported problem such as non-structural damage (e.g. fallen ceiling or damaged partitions). **Do not enter obviously unsafe structures**.
4	Assess the structure using the criteria in Table 4 and Annex 1 Table 2. Complete the Rapid Evaluation Form. Make sure that exit-ways are clear and usable. Doubtful buildings should be given a Detailed Assessment. Record any restrictions placed on use of the structure on the Rapid Evaluation form.
5	Post the structure according to the results of the assessment. Use one of the three placards INSPECTED, RESTRICTED USE, or UNSAFE. Indicate on the placard whether the inspection included only the "exterior" or the "exterior and interior" by checking the appropriate box. Post every entrance to a building classified as Restricted Use or Unsafe (except single-family dwelling).
6	Explain the significance of Restricted Use or Unsafe postings to building occupants if they are available, and **only if it is safe to do so**. Advise them to leave unsafe buildings immediately, but do not create panic. Unsafe areas must also be evacuated.

Table 5: Rapid Assessment Inspection Procedure. Adapted from ATC-20.

Ideally, assessments of critical buildings will be carried out by a team of at least two structural engineers. In the aftermath of a disaster, however, this may not always be possible. One alternative is the use of a team consisting of a structural engineer and a building inspector. There may also be scope to make use of remote assistance/advice from either National/International Engineers.

Note that sometimes the result may be inconclusive, or it is suspected that results may be questioned due to pre-existing damage, or because the assessors and occupants are known to each other. To deal with these issues, the detailed Damage Assessment form differentiates between new and pre-existing damage. For cases where the assessors and occupants are known to each other, then accurate results are somewhat facilitated by having well-defined damage states. If this issue is still of concern then it may be possible to use assessors from an area farther away, so that they are unlikely to be known to the occupants.

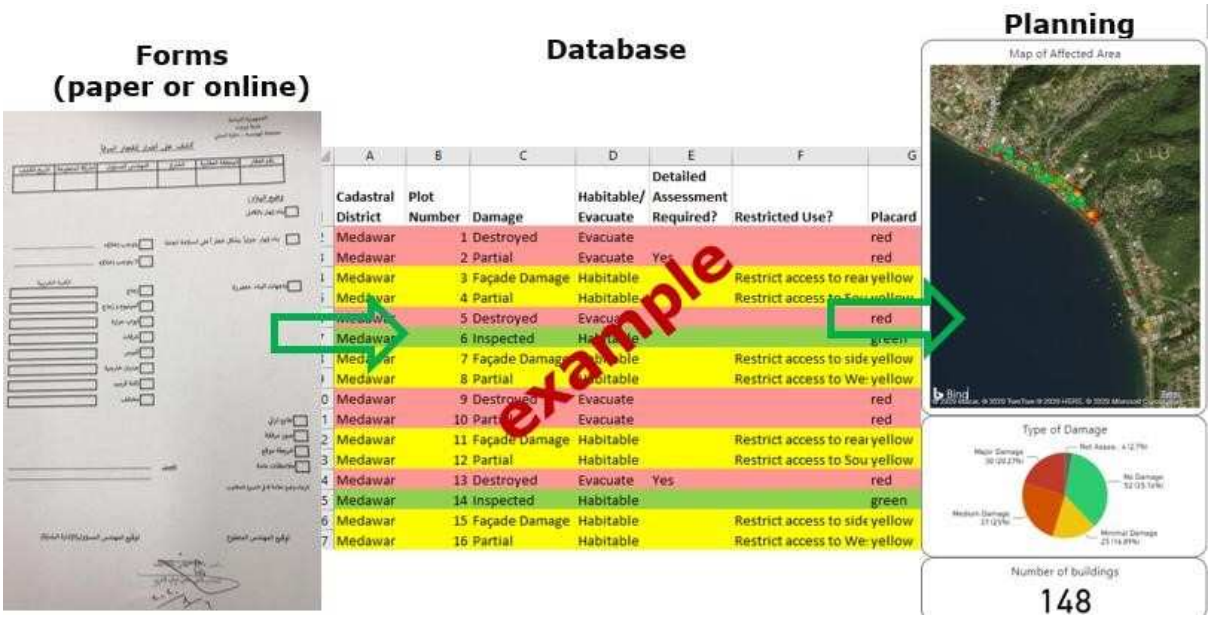
rob.davis@saraid.org.uk

2.4. Data Management

The aim of defining an efficient system for central storage, analysis and reporting of damage data, is to ensure that information is collected quickly and consistently, so that it can be accurately collated and made available for immediate and long-term decision-making. If this is not done then assessors may collect data in different ways, it may not be possible to use/combine collected data, and assessments may need to be redone.

Data will be collected via the Kobo app proposed by MTPCT, which will immediately store the data centrally. This central storage is to be managed by MTPCT. This is as agreed in the workshops described in section 1.2.

Collected data must be analysed in near-real time to identify possible errors and biases. It is important to feed these findings back to assessment coordinators continuously so that issues in the field may be addressed quickly (e.g. through additional training for assessors).



	A	B	C	D	E	F	G
	Cadastral District	Plot Number	Damage	Habitable/ Evacuate	Detailed Assessment Required?	Restricted Use?	Placard
1	Medawar	1	Destroyed	Evacuate			red
1	Medawar	2	Partial	Evacuate	Yes		red
1	Medawar	3	Façade Damage	Habitable		Restrict access to rear	yellow
1	Medawar	4	Partial	Habitable		Restrict access to Sou	yellow
1	Medawar	5	Destroyed	Evacuate			red
1	Medawar	6	Inspected	Habitable			green
1	Medawar	7	Façade Damage	Habitable		Restrict access to side	yellow
1	Medawar	8	Partial	Habitable		Restrict access to We	yellow
0	Medawar	9	Destroyed	Evacuate			red
1	Medawar	10	Partial	Evacuate			red
2	Medawar	11	Façade Damage	Habitable		Restrict access to rear	yellow
3	Medawar	12	Partial	Habitable		Restrict access to Sou	yellow
4	Medawar	13	Destroyed	Evacuate	Yes		red
5	Medawar	14	Inspected	Habitable			green
6	Medawar	15	Façade Damage	Habitable		Restrict access to side	yellow
7	Medawar	16	Partial	Habitable		Restrict access to We	yellow

Figure 3: Example Flow of Damage Assessment Data (right-hand image is a general example from UNDP Housing and Building Damage Assessment)

It is very important that there is a system whereby assessment results are continually passed to the authority that will action those results, e.g. the Police or Military. Placards and restrictions should not be placed by assessors themselves.

Data, once collected should be stored centrally, and be stored in compliance with any relevant local legislation. An electronic system of data collation should be formed as soon as possible, to facilitate gaining a rapid situational overview. This could be in the form of a simple database such as Microsoft Excel or Google Sheets. More complex relational database such as MySQL may also be used if appropriately skilled personnel are available to develop and use it. Provided the database can give clear insights into the current situation, the software used does not matter.

It is the Local Authority's responsibility to collate the damage data of the event, and all datacollection is to be done by local assessors. The role of international engineers, if available, is only to support the local assessors on the ground. All International and Local Engineers conducting the assessments should be provided with the forms that are in use, and how they are to be completed.

rob.davis@saraid.org.uk

It is often best for those persons inputting the data to ask questions of the assessment teams when the forms are submitted, this will reduce the likelihood of any unclear information being input to the database.

Photos may be collected centrally by providing a cloud folder for teams to use when/if they have internet. This is operationally useful as georeferenced photos can be mapped automatically to gain a quick overview. If cloud-based resources are not available then the images may be collated by a team of people within the Local Authority, and saved to suitable media to be uploaded to cloud services as soon as they are available.

Sharing of Data with International Agencies

Damage data collected by the Haitian assessors, is the property of the Haitian Authorities. Consideration may be made to share damage data with key international agencies, that may be able to assist the emergency, relief and recovery phase.

Key international partners to consider are those associated with any follow-on assessments, such as Post Disaster Needs Assessments by the World Bank, UN and EU.

There are many examples of organisations that are remaining in-country, to assist the Haitian Authorities with relief and reconstruction efforts. Consideration should be made whether parternships with these organisations to allow regular sharing of data may be mutually beneficial, considering also data protection laws of the Host Nation.

3. Conclusion

This document has outlined a proposal to the Haitian Authorities, on key considerations for a successful Haitian-led Damage Assessment Coordination Centre (DACC), to coordinate rapid safety assessments of critical infrastructure buildings**.** These are the findings and recommendations from a series of meetings and workshops conducted by SARAID, EUCPT, and Swiss Embassy, with key stakeholders (both National and International) between 19th – 25th September. This is in support of the MTPCT, which is the lead government organisation for damage assessment in Haiti.

This document has provided guidance on the four key components needed for an effective Haitian-led Damage Assessment Coordination system to:

1. Procedural/Legal Framework
2. Coordination of Assessors
3. Technical Building Assessment
4. Data Management

The information provided within this preliminary proposal document is presented as expert advice. The decisions and responsibilities associated with defining and implementing a coordination system for Damage Assessments by local assessors, remains wholly with the Authorities of Haiti. If any portion of this document is to be adopted in Haitian procedures, then it is recommended that the relevant sections are translated into French and/or Haitian Creole.

rob.davis@saraid.org.uk

Annex 1: Presentation of DACC Proposal to Key Stakeholders, 25th August 2021

This presentation was given at the workshop on 25th August, as described in section 1.2 and Figure 4.

The minutes of this meeting are provided in Annex 2.

rob.davis@saraid.org.uk

Damage Assessment Coordination Workshop

- to MTPTC, 24th Aug 2021

SARAID

Swiss Embassy

EUCP

Swiss Embassy
SARAID (Search & Rescue Assistance in Disasters - UK)
EUCP (EU Civil Protection Mechanism)

Damage Assessment Coordination Support

SARAID

Swiss Embassy

EUCP

Albania 2019

Beirut 2020

Haiti 2021

Why Building Safety Assessments?

- DGPC: destroyed/damaged
  - schools, places of worship, health facilities.
  - >135,000 families displaced.

- Next Steps
  - How do we get people back into their homes?
  - Should damaged hospitals be evacuated?
  - Can damaged buildings still be used as hurricane shelters?
  - Which parts of damaged schools can still be used?

Why Building Safety Assessments?

- 30-50 patients located outside the hospital.
- But preliminary assessment by international Engineers suggests the building is structurally safe to reoccupy.

Building Safety Assessment Coordination in Sud

The 4 components of damage assessment

	Component	Objective
1	Procedural/Legal Framework	Official system of working, and evacuating unsafe buildings
2	Coordination of Assessors	Efficient organization of damage assessors
3	Technical Building Assessment	A consistent method to decide: evacuate / don't evacuate
4	Data Management	Efficient system for central storage, analysis and reporting of damage data

Agreed within Sud:

- Arranged by IOM
- MTPTC
- UCLBP invited
- Mayor of Les Cayes
- DPC
- Habitat for Humanity

Building Safety Assessment Coordination in Sud

- **Legal/Procedural:**
  - Buildings of public interest (hospitals, schools, churches etc)
  - Building safety only. Not advice on demolition, reconstruction, cost.
  - Licensed Haitian Engineers

- **Coordination of Assessors:**
  - Prioritise the needs.
  - Manage list of assessors.
  - Form assessors into teams.
  - Assign assessors to Communes.

- **Technical Building Assessment**
  - MTPTC assessment form, with agreed updates
  - Extra material
  - Training

- **Data Management**
  - Online system (Kobo)
  - Managed by:
    - MTPTC
    - IOM
    - Habitat For Humanity

Our Understanding: Coordination Structure

MTPTC

- Provide engineers for assessment
- Support coordination of national engineers

UCLBP

- Technical support of assessment forms/process

DPC

- Logistical support, office space.
- Enforcement of evacuation and safety procedures.

IOM

- Lead coordination of national and international engineers

Proposal: Training Workshop for Engineers

Albania 2019

Beirut 2020

Haiti 2021?

Thank You!

SARAID

Swiss Embassy

EUCP

Special Thank You to IOM

Annex 2: Minutes of Meeting to Discuss Coordination of Building Safety Assessments following 2021 Haiti Earthquake

These are the minutes of the workshop on 25th August, as described in section 1.2 and Figure 4. The presentation given is provided in Annex 1.

Please note that these minutes are notes compiled by SARAID, and have not yet been commented on by other attendees of the meeting.

rob.davis@saraid.org.uk

Minutes: Meeting to Discuss Coordination of Building Safety Assessments following 2021

Details

- **Date**: 25th Aug 2021, 10am
- **Location**: Minestere des Traveaux Publics, Delmas 33, Rue Louverture #27

Attendees

- **MTPTC**: Raymond Hygin, Pierre Peguy
- **UNOPS**: Felipe Munevar, Achille Theodore, Matthieu Bastien
- **IOM**: Federica Cecchet
- **Miyamoto International**: Kit Miyamoto, Sabine Kast, Vidore Guilane
- **EUCP**: Lukes Miroslav, Kristin Horth
- **Swiss Embassy**: Alessio Omatta, Letang Gardy
- **SARAID UK**: Rob Davis, Josh Macabuag

Fig: Damage Assessment Coordination meeting

Key Take-Aways

- MTPTC is the lead on all damage assessments, with support from other organisations such as UNOPS, IOM, Miyamoto International and others.
- Haiti has extensive expertise in damage assessment, with successful assessments conducted following the 2010 Earthquake and Hurricane Matthew in 2018.
- Director Raymond Hygin (MTPTC) suggested 2 separate stages of structural assessments, both to be lead by MTPTC:
    1. Rapid Safety Assessments of critical buildings (hospitals, schools, churches, hurricane shelters, etc) in urban/accessible areas.
    2. Comprehensive Assessments of the entire affected region, including residential buildings.
- Rapid Safety Assessments are to begin as soon as possible.
    - The objective is to provide decisions on whether critical buildings should be evacuated (red-tagged), have use-restrictions (orange-tagged), or if the earthquake has not reduced the capacity of the structure (green-tagged).
    - The MTPTC Form is to be adopted, with minor suggested amendments as proposed by Swiss Embassy and further amendments discussed during the meeting.
    - International Engineers (SARAID-UK, Swiss Embassy, EUCPT) have been working in Les Cayes for the past days to support the local agencies prepare to begin MTPTC-led damage-assessments, once central approval is received. This is in response to a request made to SARAID-UK by Director General of the Directorate of Civil Protection, Dr Jerry Chandler, to assist damage assessment in the region.
    - Assessments are to be conducted asap to take advantage of the presence of international Engineers, who are only in country for the next few days.
    - Training is to be conducted by Engineers of the Swiss Embassy and EUCP in Les Cayes, on Friday morning. Assessments can begin thereafter.
- In parallel, preparations for long-term, Comprehensive Assessments of the entire affected region are to take place.
    - This work is led by UNOPS and Miyamoto International, and will begin once preparations are complete, expected to be a few weeks.

Additional Notes

Notes arranged by subject (i.e. not necessarily chronological).

Presentation by SARAID UK: Damage Assessment Coordination Workshop (attached to these minutes)

- DG Chandler requested SARAID go to Les Cayes to provide assistance regarding damage assessments of critical buildings.
- Example finding: Notre Dame Hospital, Les Cayes has around 50 patients sleeping outside, whereas the building appears undamaged by the earthquake. They require an official MTPTC assessment before feeling able to reenter the building.
- IOM Engineer in Les Cayas, helped arrange workshops with key partners in Sud.
- Workshops have been conducted with partners to define necessary details of a damage assessment coordination centre, considering: (1) the legal/procedural system, (2) coordination of assessors, (3) technical method of assessment, (4) data management.
- Training can be made available for Haitian engineers.

Assessment Form

- Alessio (Swiss Embassy): talked through some minor suggested amendments to the MTPTC form (attached to these minutes).
- Filipe (UNOPS): Move H009 (partial collapse) to end of section, as is a conclusion informed by preceding questions.
- Raymond (MTPCT): Remove J009 (foundation type), as generally not known.
- Josh (SARAID): Change L0014 (damage level), to “decision regarding tag”. Clarified that a single traffic-light tag is proposed, and the text of this question should be changed from ‘damage level’ as tag decision does not always relate to physical damage to the building.
- Filipe (UNOPS): Move L0015 (habitability) to before L0014, as it informs the decision regarding tag.

Assessment General

- Federica (IOM): MTPTC in charge of all assessments.
- Sabine (Miyamoto): Haiti has extensive expertise in damage assessment, with successful assessments conducted following the 2010 Earthquake and Hurricane Matthew in 2018. Many other good case studies, e.g. Columbia.
- Kit (Miyamoto): Quality control is key to reduce the error rate. Gave example of California where error rate of licensed engineers was recorded as high as 15%.
- Kit (Miyamoto): Aftershocks can occur significantly later than the main shock, be in a different location and with a different frequency content (gave example of Christchurch Earthquake Sequence 2010-2011). So must be clear that green tag does not mean safe, but merely ‘inspected’. Important to communicate to occupants.
- Felipe (UNOPS): green indicates that an earthquake has not reduced the structural capacity of the load-carrying elements.

Comprehensive Assessments

- Felipe (UNOPS):
  - Systematic Comprehensive Assessments of the entire affected region are to take place, funded by the, e.g., the World Bank.
  - This work is led by MTPTC, supported by UNOPS and Miyamoto International.
- Kit (Miyamoto):
  - Assessments include both damage components and repair components.
  - Will begin once preparations are complete, expected to be a few weeks.
  - In reality, rural areas will not have 2 assessments (rapid and detailed) assessments. Needs to be done in one assessment.
  - Training and preparations already taken place in Haiti. Engineers trained, form designed and in Kobo platform.

Rapid Assessments

- Rob (SARAID): Patients outside Notre Dame hospital, when building has not been significantly damaged. Gave example of an individual, Eric, who was visiting his 80-year old father in very poor state being treated in under a gazebo rather than in the hospital, nearly 2 weeks after earthquake.
- Josh (SARAID):
  - The Damage Assessment Coordination Centre (DACC) in Albania 2019 and Beirut 2020 was up and running by day 3 of both events, to meet immediate needs of life-safety buildings.
  - National and international Engineers have been preparing a damage assessment coordination centre in Les Cayes for several days, in preparation for receiving confirmation from MTPTC to proceed with assessments. Contacts have been gathered, an office space is provided as part of OSOCC, locations have started to be identified, and preliminary advisory assessments have been conducted by international engineers.
- Felipe (UNOPS):
  - Comprehensive Assessment design to take a few weeks, but should not delay the rapid assessment process being proposed in Les Cayes.
  - There is also a current opportunity to use the international engineers available for the next few days. Requested that international engineers remain for an additional 2 weeks.
- Kit (Miyamoto): Rapid assessment proposal not suitable for remote rural areas.
- Raymond (MTPTC):
  - 1st wave of assessments to be focussed on critical infrastructure buildings.
  - 12 MTPTC Engineers available to support (4 Engineers in each Province).
  - Engineers will be available for training Fri am.

Assessment Form

- Raymond (MTPTC):
  - Kobo form can be amended today/tomorrow, ahead of training on Fri.
- Alessio (Swiss Embassy):
  - Amendments to the Kobo form are to begin following the meeting. Any further comments received by tomorrow morning will be incorporated.

Annex 3: Proposed Guidance Note to Accompany Assessment Form

This Guidance Note was provided to colleagues from Swiss Embassy upon SARAID's departure, but it is not known if it was implemented and provided to assessors.

This annex provides a 3-page field guide for assessors. This field-guide builds on the existing MTPTC Building Damage Assessment form, and provides step-by-step guidelines for conducting assessments, classifying damage, and deciding whether a building should be evacuated. This is following field-observations that there were some inconsistencies in the ways that different assessors were conducting their assessments, and also following discussion/agreement with key stakeholder.

The recommended procedure to be followed by the assessors, comprises a single-page assessment form and two-page Guidance Note. For a more detailed Standard Operating Procedure (SOP), the assessors are referred to the FEMA P-2055 and ATC-20.

It should be noted that the procedures and *simplified* criteria outlined in the Guidance Note are provided as *simplified* guidance to allow a common framework for *suitably qualified, experienced and trained engineering assessors* to make consistent technical judgements. In other words, the simplified criteria outlined in the form is *guidance only*, and assessors are expected to study the more extensive examples and guidance.

This guidance may be refined as per the Haitian authorities' needs. Please note that defining a SOP is only part of the requirement for the damage assessments, and in the coming days the following must be defined:

- the procedure for calling for an inspection,
- the recruitment and the management of the assessment teams
- the extent of the area to be assessed
- the computerization of the data included in the form,
- the procedures for the order of evacuation,
- the procedure for requesting and undertaking a Detailed Assessment.

rob.davis@saraid.org.uk

Rapid Assessment: Guidance Notes

The *simplified* criteria below, is to allow suitably qualified and trained assessors to make consistent decisions on whether a building is safe to live in (habitable), or should be evacuated. For more detailed advice, assessors should refer to ATC-20[1].

Key Points:

- Assessors to make a *roughly* 30-40 minute assessment per building.
- The assessment process is in Table 1 below.
- Outcome is to decide if the building should be posted as one of the following (Figure 1):
  - **red** (unsafe / evacuate),
  - **yellow** (habitable but with restrictions),
  - **green** (inspected)
- Guidance on decision 'habitable vs evacuate' is in Table 2.

1	Examine the entire outside of the structure.
2	Examine the ground and pavement in the general area of the structure for fissures, bulged ground, or signs of slope movement.
3	Enter a building when the structure cannot be viewed sufficiently from the outside and when there is a suspected or reported problem such as non-structural damage (e.g. fallen ceiling or damaged partitions). **Do not enter obviously unsafe structures.**
4	Assess the structure using the criteria in Table II and Table III.
5	Complete the Rapid Assessment Form. Record any restrictions placed on use of the structure on the Rapid Evaluation form. Questionable buildings should be recommended for a Detailed Assessment.
6	Explain the significance of Inhabitable or Uninhabitable postings to building occupants, if they are available. Advise them to leave unsafe buildings immediately, but do not create panic. Unsafe areas must be also evacuated.

**Adapted from ATC-20.*

*Table 1: Rapid Assessment Inspection Procedure**

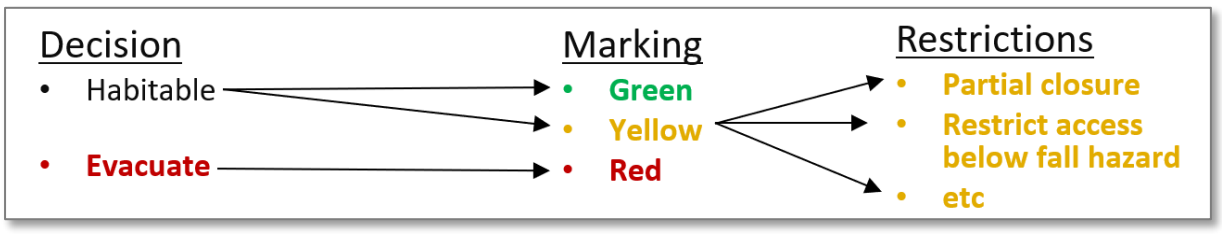


*Figure 1: Assessment Outcomes**

[1] ATC 20-1 *Field Manual: Postearthquake Safety Evaluation of Building (2nd Edition)*, 2005

	Visual Signs of Damage
Habitable (YELLOW, or GREEN)	Slight cracks in render (plaster) of the wall and/or ceiling Damage limited to windows, doors and non-structural items (that are not at risk of falling onto inhabitants) Slight cracks in walls (load-bearing and/or non-load-bearing), and slight separation between load-bearing and non-load-bearing elements Hairline, non-diagonal cracks in horizontal reinforced concrete structural beams Hairline cracks in load-bearing masonry walls, where the cracking covers less than 30% of the wall area
Evacuate (RED)	Total or partial collapse of the building Major damage and deformation, deviation from the vertical of of load-bearing structure Severe damage to the beam-column joints Neighbouring structure in danger of collapse onto building The load-bearing elements show any deformation Floor panels displaced away from original supports Load-bearing shear-walls show any out-of-plane deformation Significant cracks (>2mm) in load-bearing elements made of reinforced concrete Significant (>2mm) cracks in load-bearing walls Hairline cracks in load-bearing masonry walls, where the cracking covers more than 30% of the wall area Diagonal cracking or crumbling of the material in the walls between the windows or doors or similar elements of construction • Damage or collapse, or significant *distortion* of the roof • Slight damage, partial or complete *sliding* of the roof • Large items that could fall and cause harm, including: glass, detached aircon units, water tanks, cladding, plaster etc. • Significant damage to support of cladding and other non-structural fittings (often not visible externally) • Damage or partial failure of chimneys, parapets • Damage or partial failure of balconies • Non-load-bearing walls: Large diagonal cracks, collapse of infill walls and major separation between infill walls and structural elements

Table 2: Guidelines for defining whether an evacuation is needed[2]

[2] Adapted from: *Engineer's Manual*, Greek General Directorate for the Rehabilitation of the Impacts from Natural Disasters (DAEFK). Greek Name: Γ.Δ.Α.Ε.Φ.Κ. (Γενική Διεύθυνση Αποκατάστασης Επιπτώσεων Φυσικών Καστροφών)

Light Damage

Medium – Severe Damage

Heavy Damage

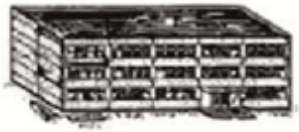
DS1	DS2	DS3	DS4	DS5
				
Grade 1: Negligible to slight damage *(no structural damage, slight non-structural damage)*	**Grade 2: Moderate damage** *(slight structural damage, moderate non-structural damage)*	**Grade 3: Substantial to heavy damage** *(moderate structural damage, heavy non-structural damage)*	**Grade 4: Very heavy damage** *(heavy structural damage, very heavy non-structural damage)*	**Grade 5: Destruction** *(very heavy structural damage)*
Fine cracks in plaster over frame members or in walls at the base. Fine cracks in partitions and infills	Cracks in columns and beams of frames and in structural walls. Cracks in partition and infill walls; fall of brittle cladding and plaster. Falling mortar from the joints of wall panels	Cracks in columns and beam column joints of frames at the base and at joints of coupled walls. Spalling of concrete cover, buckling of reinforced rods. Large cracks in partition and infill walls, failure of individual infill panels	Large cracks in structural elements with compression failure of concrete and fracture of rebars; bond failure of beam reinforced bars; tilting of columns. Collapse of a few columns or of a single upper floor	Collapse of ground floor or parts (e. g. wings) of buildings

Figure 1: Damage Level mapped to the EMS-98 Damage Scale [3]

[3] Grünthal, G. (Ed.) (1998): European Macroseismic Scale 1998 EMS-98, (Cahiers du Centre Européen de Géodynamique et de Séismologie ; 15), Luxembourg : Centre Européen de Géodynamique et de Séismologie, 101 p.