USAID | LEBANON
FROM THE AMERICAN PEOPLE

LITANI RIVER BASIN MANAGEMENT SUPPORT PROGRAM

EMERGENCY ACTION PLAN FOR QARAOUN DAM

SEPTEMBER 2012
This report was produced for review by the United States Agency for International Development (USAID). It was prepared by International Resources Group (IRG) under Contract EPP-I-00-04-00024-00 order no 7.

LITANI RIVER BASIN MANAGEMENT SUPPORT PROGRAM

EMERGENCY ACTION PLAN FOR QARAOUN DAM

Contract No.: EPP-I-00-04-00024-00 order no 7.

September 2012

DISCLAIMER
The author's views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government

TABLE OF CONTENTS

EXECUTIVE SUMMARY ..... **I**

1. INTRODUCTION **1**

1.1. Context 1
1.2. What is an Emergency Action Plan? 1
1.3. Basic Elements of an Emergency Action Plan 2
1.4. Qaraoun Dam Emergency Action Plan 3

2. EMERGENCY PROCEDURES **4**

2.1. Emergency Levels 4
2.2. Emergency Notifications 6
2.3. Emergency Measures 6
2.3.1. Emergency measures at the dam 6
2.3.2. Emergency measures downstream 7

3. EXECUTION OF EMERGENCY ACTION PLAN **8**

3.1. Preparation 8
3.2. Awareness Raising 8
3.3. Implementation 9

4. REFERENCES **10**

EXECUTIVE SUMMARY

CONTEXT

An essential responsibility of government is to protect people. One of the usual methods is advance planning for potential catastrophic events, either natural or man-made. This document presents a recommended Emergency Action Plan (EAP) for reacting to the unlikely event of a failure of Qaraoun dam. Properly executed, this EAP can minimize loss of life and mitigate material damage.

Qaraoun Dam is the largest dam in Lebanon, and has been providing hydropower and irrigation water for now almost 50 years. It is expected to continue to do so thanks to proper operation and maintenance by the Litani River Authority (LRA), as well as to the dam safety monitoring equipment provided and installed by the USAID-funded Litani River Basin Management Support (LRBMS) program. Recent seismic safety analyses conducted by LRBMS have demonstrated that the dam is in good condition and would safely withstand a large earthquake without failing. However, conditions within the dam body can change and an earthquake of larger magnitude is also a possibility. Therefore, an action plan is necessary to prepare the LRA, local authorities as well as populations downstream of Qaraoun Dam to take action if extreme events result in partial or full dam failure.

A common argument is that discussing and preparing for the unlikely event of dam failure may unnecessarily alarm downstream populations. Experience has shown many times that ignoring a catastrophic possibility because it is very unlikely results in maximum impacts when such an event occurs, while conversely proper awareness and simple procedures can often prevent loss of life and significantly mitigate material damage.

PURPOSE OF THIS EMERGENCY ACTION PLAN

This plan defines responsibilities and provides procedures designed to identify unusual and unlikely conditions around Qaraoun Dam in order to notify appropriate authorities, take timely action, and hopefully safeguard the lives and reduce damage to the property of residents along the lower Litani River in the event of failure of the Dam or flooding caused by large runoff.

The following page identifies the emergency levels to be considered and defines the notification process. The main body of the report provides additional details on the recommended emergency and alert

procedures. As an additional recommendation, the proposed communication/alert procedures should be practiced on a regular basis (at least annually).

EMERGENCY LEVELS AND NOTIFICATION FLOWCHART

Emergency level	Notifications when emergency level is changed (who to call?)	Frequency of notification updates (when to call again?)
0 Normal situation	No	No
1 Unusual situation, no immediate danger: ○ High level of reservoir (reaches spillway crest) ○ Exceptional rainfalls ○ Moderate Earthquake ○ Some leaks/disturbances observed on dam slopes ○ Dam safety monitoring data is beyond usual values. ○ Verified bomb threat on dam ○ Damage (vandalism/sabotage) to dam or attached structures	Engineer in charge of Qaraoun Dam notifies immediately: ○ LRA General Director ○ Head of Hydro-Electric Production And dispatches staff to visually inspect dam	LRA General Director to be kept informed at least twice daily, or immediately if emergency level increases
2 Possible emergency situation, or dam potentially failing: ○ Reservoir level reaches 0.5m higher than spillway crest ○ Earthquake resulting in visible damage to the dam ○ Large disturbances observed on the dam (slides, cracks) ○ Detonated bomb resulted in damage to dam ○ Damage to dam (vandalism/ sabotage) resulted in seepage flow	Engineer in charge of Qaraoun Dam notifies immediately: ○ LRA General Director and Head of Hydro-Electric Production ○ Ministry of Energy and Water (General Director of Exploitation) ○ Civil Defense (125) ○ Downstream Municipalities And keeps staff permanently observing the dam	After initial alert call, all contacts will be kept informed every 2 hours about the situation at dam site or immediately if emergency level increases
3 Emergency situation, or dam failing: ○ Reservoir is 1 m higher than spillway crest, very large spillway flow ○ Very large disturbances observed on the dam and increasing over time (settlement of dam crest, slides, cracks, large leaks, etc.)	Same as above and downstream Municipalities should be informed to evacuate flood-prone areas at once	After initial alert call, all contacts will be kept informed hourly about the situation at dam site

This page should be posted at LRA's office on Lake Qaraoun for instant reference along with the contact list (next page) which has to be kept up-to-date.

CONTACT LIST

Institution	Name	Contact
Litani River Authority		
Engineer in charge of Qaraoun Dam	Eng. Mahmoud Ibrahim	Cell 03 695 074 office 08 650 377
General Director	Eng. Adel Houmany	Cell 03 504 672 office 01 666 661
Head of Hydro-electric Production	Eng. Ghassan Gebran	Cell 03 438 992 office 01 662 482
Ministry of Energy and Water		
General Director of Exploitation	Ghassan Beydoun	Cell ??? office ???
Downstream Municipalities		
Sohmor		
Yohmor el Beqaa		
Ed Dellafi		
Tair Semhat		
Tair Falsay		
Qasmiye		
Date:		
(page to be updated at least annually)		

1. INTRODUCTION

1.1. CONTEXT

Qaraoun Dam is the largest dam in Lebanon, and has been providing hydropower and irrigation water for the past 50 years. It is expected to continue to do so thanks to proper operation and maintenance by the Litani River Authority, as well as to the dam safety monitoring equipment provided and installed by the USAID-funded Litani River Basin Management Support (LRBMS) program.

Recent seismic safety analyses conducted by LRBMS have demonstrated that the dam is in good condition and would safely withstand a large earthquake without failing. However, conditions within the dam body can change in the future and an earthquake of larger magnitude is also a possibility. Therefore, an action plan is necessary to prepare the LRA, local authorities as well as populations downstream of Qaraoun Dam to take action if extreme events result in partial or full failure of the dam.

In the case of large dams, Emergency Action Plans are compulsory in many countries to minimize damage and loss of life. Such plans describe and prescribe simple procedures for dam operators to alert downstream communities.

1.2. WHAT IS AN EMERGENCY ACTION PLAN?

An Emergency Action Plan (EAP) is a formal plan that:

- Identifies emergency conditions that could endanger the integrity of the dam and which require immediate action;
- Prescribes procedures which should be followed by the dam owner and operating personnel in the event of an emergency;
- Provides timely warning to appropriate emergency management agencies for their implementation of protection measures for downstream communities.

The standards used for design, construction, operation, maintenance and inspection of dams are intended to minimize the risk of dam failure. However, since unusual circumstances could result in dam failure, dam owners need to plan for the unlikely event of a partial or full failure of the dam. An EAP provides the dam owner with a preset list of actions to take when an emergency strikes in order to alert the proper authorities and downstream populations in a timely manner. An EAP identifies conditions

which could lead to failure situations and which may require a dam safety emergency response. An EAP alsoidentifies who is responsible for undertaking particular actions under emergency circumstances. EAPs are tailored to the conditions at each dam.

1.3. BASIC ELEMENTS OF AN EMERGENCY ACTION PLAN

The six basic elements of an EAP are:

1) **Notification Procedures (refer to section 2.2)**. A notification flowchart shows who is to be notified, by whom, and in what priority. The information on the notification flowchart is necessary for the timely notification of persons responsible for taking emergency actions.
2) **Emergency Levels (refer to section 2.1).** Early detection and proper evaluation of the situation(s) or triggering event(s) that initiate or require an emergency action are crucial. The establishment of procedures for reliable and timely classification of an emergency situation is imperative to ensure that the appropriate course of action is taken based on the urgency of the situation. It is better to activate the EAP while confirming the extent of the emergency than to wait for the emergency to occur.
3) **Responsibilities (refer to sections 2.2 and 2.3).** A determination of responsibility for EAP-related tasks must be made during the development of the plan. Dam owners are responsible for developing, maintaining, and implementing the EAP. State and local emergency management officials having statutory obligation are responsible for warning and evacuation within affected areas. The EAP must clearly specify the dam owner's responsibilities to ensure effective, timely action is taken should an emergency occur at the dam.
4) **Preparedness.** Preparedness actions are taken to moderate or alleviate the effects of a dam failure or operational spillway release and to facilitate response to emergencies. This section identifies actions to be taken before any emergency.
5) **Inundation Maps (see Appendix B).** An inundation map should delineate the areas that would be flooded as a result of a dam failure. Inundation maps are used both by the dam owner and local emergency management officials to facilitate timely notification and evacuation of areas affected by a dam failure or flood condition. These maps greatly facilitate notification by graphically displaying flood-prone areas and showing travel times for wave front and flood peaks at critical locations.
6) **Appendices.** As necessary, appendices contain information that supports and supplements the material used in the development and maintenance of the EAP.

1.4. QARAOUN DAM EMERGENCY ACTION PLAN

The present Emergency Action Plan addresses the steps to be taken in the unlikely case of a failure of Qaraoun Dam. It defines emergency levels, and the corresponding notifications and actions that have to be carried out based on the emergency level.

Maps in Appendix B show the maximum areas that would probably be flooded in case of dam failure while the reservoir is full. The actual inundation area may vary, depending on the conditions existing at the time of dam failure, and the degree of failure. Nevertheless, in case of confirmed emergency (dam failure or large flood), the entire flood-prone area should be evacuated as quickly as possible.
The time lag between dam failure and arrival of the flood wave is at most 3 hours (at the sea outlet). Thus, the possibility of downstream flooding must be recognized early and notification of downstream communities must be made without delay.

2. EMERGENCY PROCEDURES

Emergency procedures follow three simple steps:

- Determination of the emergency level (how bad is the situation?);
- Contact relevant authorities (especially downstream municipalities) when the emergency level requires it; and
- Raise the alarm and conduct evacuation procedures once the emergency is confirmed.

The Litani River Authority (LRA) is responsible for the first two steps, while alarm and evacuation procedures rely on local authorities, Municipalities and Civil Defense.

2.1. EMERGENCY LEVELS

Four levels are to be considered:

- **<u>Level 0, normal situation</u>: dam, reservoir and appurtenant structures are all operating as usual; as confirmed by safety information being within known values; no exceptional natural event (heavy rain, recent earthquake, etc.) has been identified in the region of the dam;**
- **<u>Level 1, unusual situation</u>: no immediate danger is perceived, but one or more of the following unusual conditions require closer monitoring:**
    - Spillway and/or bottom outlet is blocked/inoperative.
    - Reservoir is at spillway crest level, spillway flow is significant.
    - Exceptional storm rainfalls occurred at the dam or in the upstream basin.
    - Measurable earthquake felt or reported on or within 50 miles of the dam.
    - Some disturbances observed in the dam: new seepage areas in or near the dam, visual movement/slippage of the downstream slope, new cracks in the upstream concrete facing.
    - Dam safety monitoring data is beyond usual values.
    - Verified bomb threat that, if carried out, could result in damage to the dam.

- Damage (vandalism/sabotage) to dam or attached structures that could adversely impact the functioning of the dam.

- **<u>Level 2, possible emergency situation, or dam is potentially failing</u>:**
  - Reservoir is at spillway level, and spillway and/or bottom outlet is blocked/inoperative.
  - Reservoir is 0.5 m higher than spillway crest level, spillway flow is large and could result in flooding of buildings and people downstream.
  - Earthquake resulting in visible damage to the dam.
  - Large disturbances observed in the dam: substantial seepage areas in or near the dam, large movement/slippage of the downstream slope, significant cracks in the upstream concrete facing.
  - Detonated bomb or vandalism/sabotage that has resulted in damage to the dam and seepage flow.
- **<u>Level 3 emergency situation, or dam is failing:</u>**
  - Reservoir is 1 m higher than spillway crest level, spillway flow is very large and will result in flooding of buildings and people downstream.
  - Very large disturbances observed in the dam and increasing over time: substantial seepage areas in or near the dam with ongoing erosion, continuing movement/slippage of the downstream slope, significant cracks in the upstream concrete facing with uncontrolled water release.
  - Damage to dam (bomb/vandalism/sabotage) or attached structures that has resulted in uncontrolled/large water release.

2.2. EMERGENCY NOTIFICATIONS

Emergency level	Notifications when emergency level is changed (who to call?)	Frequency of notification updates (when to call again?)
0 Normal Situation	No	No
1 Unusual Situation	Engineer in charge of Qaraoun Dam notifies immediately: ○ LRA General Director ○ Head of Hydro-Electric Production And dispatches staff to visually inspect dam	LRA General Director to be kept informed at least twice daily, or immediately if emergency level increases
2 Possible Emergency	Engineer in charge of Qaraoun Dam notifies immediately: ○ LRA General Director and Head of Hydro-Electric Production ○ Ministry of Energy and Water (General Director of Exploitation) ○ Civil Defense (125) ○ Downstream Municipalities And keeps staff permanently observing the dam	After initial alert call, all contacts will be kept informed every 2 hours about the situation at dam site or immediately if emergency level increases
3 Emergency	Same as above and downstream Municipalities should be informed to evacuate flood-prone areas at once	After initial alert call, all contacts will be kept informed hourly about the situation at dam site

2.3. EMERGENCY MEASURES

2.3.1. EMERGENCY MEASURES AT THE DAM

The following measures should be considered and possibly implemented taken by LRA staff in charge of the dam:

- When an unusual rise in reservoir level results in very high spillway discharges, consideration should be given to opening the low level outlet in order to reduce the rise in reservoir level. This will add to the magnitude of the downstream flood wave and should not be done until downstream municipalities are warned.

- In cases when the reservoir level is rising but has not yet reached the spillway crest, if large floating trash such as trees are in the reservoir , these should be removed (e.g. towed to shore using a boat).

- If open cracks are observed in the dam face after an earthquake, visual inspections should be carried out as soon as possible, using underwater the Remotely Operated Vehicle (ROVER) provided by LRBMS; located underwater cracks should be repaired soonest if the flows are significant and increasing, possibly by dumping graded gravel on the upstream face; lasting repairs should anyway be planned and carried out in the Fall when reservoir level is at the lowest.

- If the dam settles after an earthquake and is in danger of being overtopped by the reservoir, emergency repairs should be started immediately by dumping graded rockfill on the low areas. Lasting repairs should anyway be planned and carried out in the Fall when reservoir level is at the lowest.

2.3.2. EMERGENCY MEASURES DOWNSTREAM

Municipalities potentially affected (refer to contact list in Appendix) should immediately:

- **Alert inhabitants residing in the floodable areas;**

- **Close roads and bridges that cross the valley and would be submerged;**

- **Mobilize small boats for use in rescuing inhabitants stranded by flood waters**

- **Maintain communications with all agencies involved in disaster relief and with LRA.**

3. EXECUTION OF EMERGENCY ACTION PLAN

3.1. PREPARATION

Implementation of this Emergency Management Plan (EAP) rests directly with the LRA Head of the hydropower Production Department. This person should conduct the following pre-activation activities:

1) Hold orientation meetings for LRA upon acceptance of the EAP and annually thereafter;

2) Hold orientation meetings with Civil Defense and local Municipal persons assigned to disaster management duties; and

3) Distribute the EAP (including flood maps) to Civil Defence and downstream Municipalities.

These meetings should be repeated annually. In addition to providing an orientation to the EAP, the meetings should confirm that all non-LRA parties have their emergency procedures in place. **The contact list should be updated when one of the contact information changes and checked at least annually by calling all contact persons.**

3.2. AWARENESS RAISING

Meetings should be held in each Municipality where significant risk exists (see list in contact list) in order to:

- Raise awareness as to which areas would be flooded (inundation maps in Appendix) should be provided to each Municipality and discussed with them);
- Define evacuation routes and rendezvous points; and
- Define alarm/warning procedures (how will residents be promptly informed?).

Proper awareness raising should present a balanced discussion stressing the facts that Qaraoun Dam is an essential infrastructure for Lebanon and the risk of failure is extremely low with the simple warning and evacuation procedures that would be followed in case of failure.

As a side note, Municipalities should also use inundation maps when they plan urban development and award construction permits. Public infrastructure (schools, hospitals, cantonments, malls and any other

buildings meant to take in large numbers of people), as well as critical infrastructure (e.g. electric transformers etc.) should preferably not be built in floodable areas. All other residents should simply be made aware.

3.3. IMPLEMENTATION

Operation and Maintenance (O&M) of Qaraoun Dam is the responsibility of the LRA Head of Qaraoun Dam and Markabe Powerplant. This person is the designated responsible emergency responder at the dam site, with assistance from the dam O&M staff. These technicians are the first ones to identify that ***the potential for an emergency exists.*** They accomplish this by:

Flood Emergency: Monitoring reservoir levels and as the reservoir nears the level of the spillway crest they will check the magnitude of inflows to the reservoir. If inflows are low, there is no immediate danger of excessive spillway discharges but monitoring of reservoir inflows and level is required twice a day. If inflows are high or increasing when the reservoir level is at or above the spillway crest, the danger of flooding is a definite concern.

Dam Failure Emergency. Collecting and reviewing the instrumentation data and perform visual inspections of the dam on a regular basis.

Occurrence of Earthquake: Performing a visual inspection of the dam and reviewing recent data from the dam monitoring instrumentation.

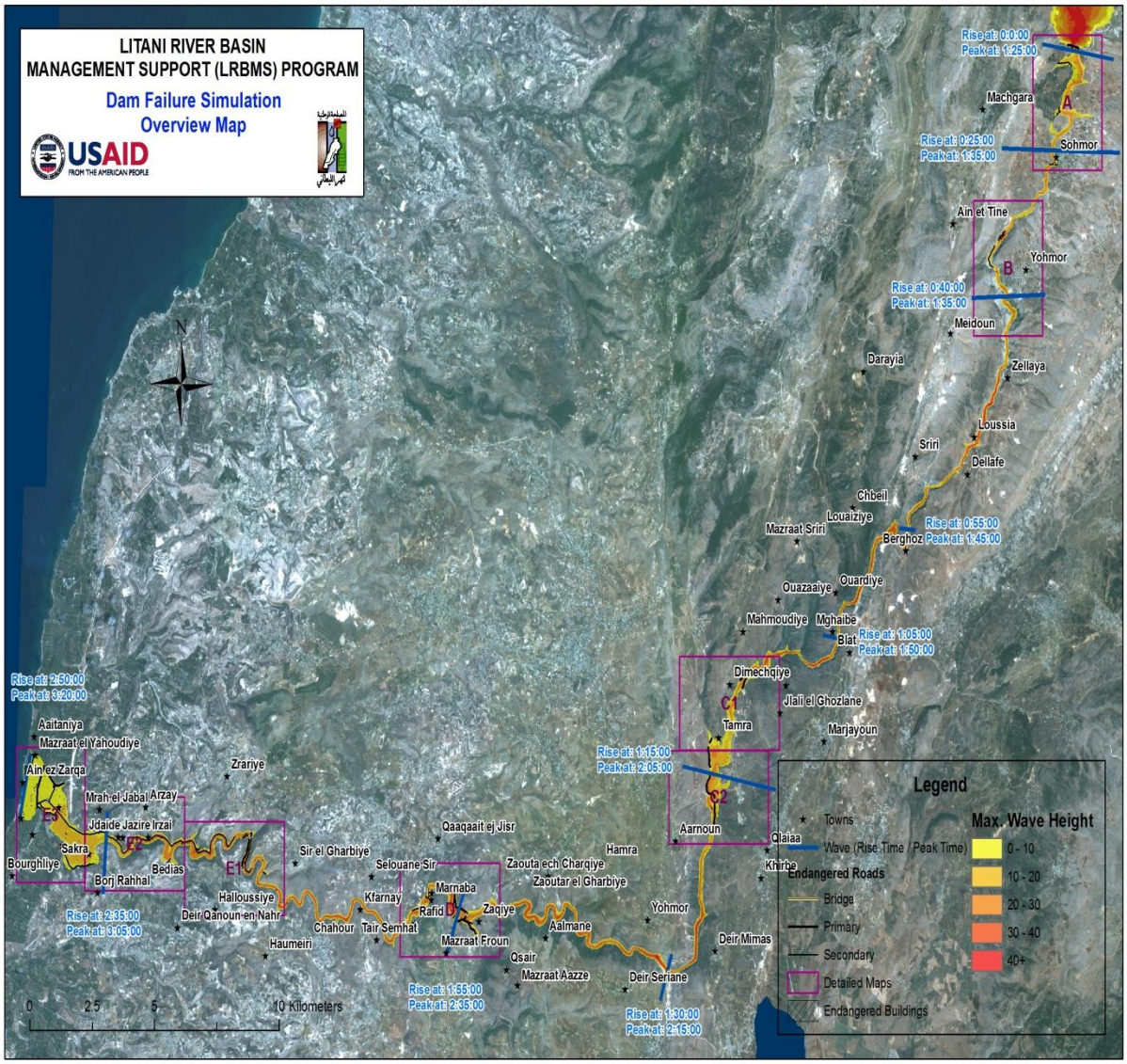
When information from O&M staff or dam safety monitoring data indicate a possible change in the Emergency Level, Head of Qaraoun Dam should take such decision and implements the proper notification procedures.

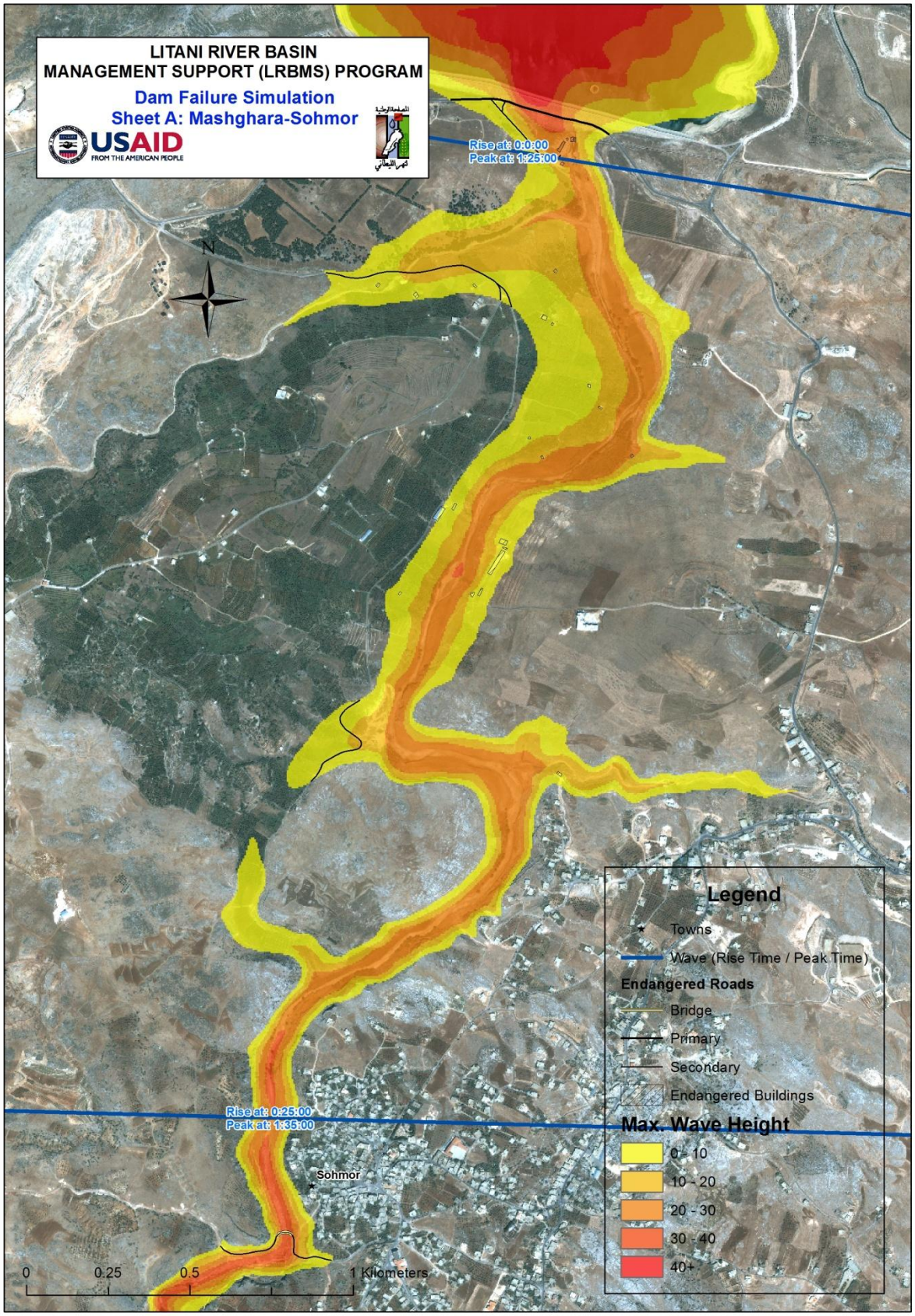
The final decision about evacuating flood-prone areas rests with Civil Defense and local Municipalities.

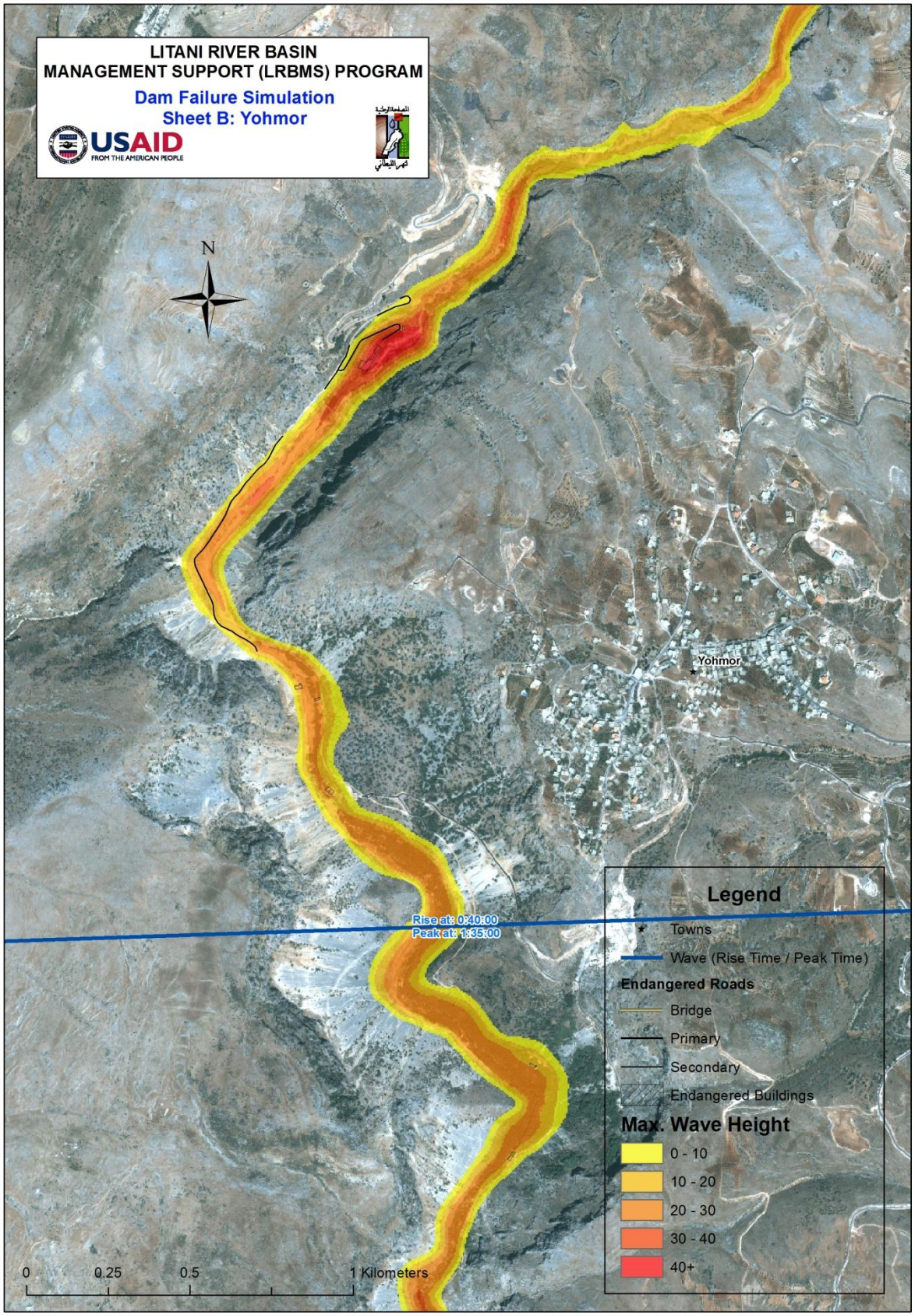
4. REFERENCES

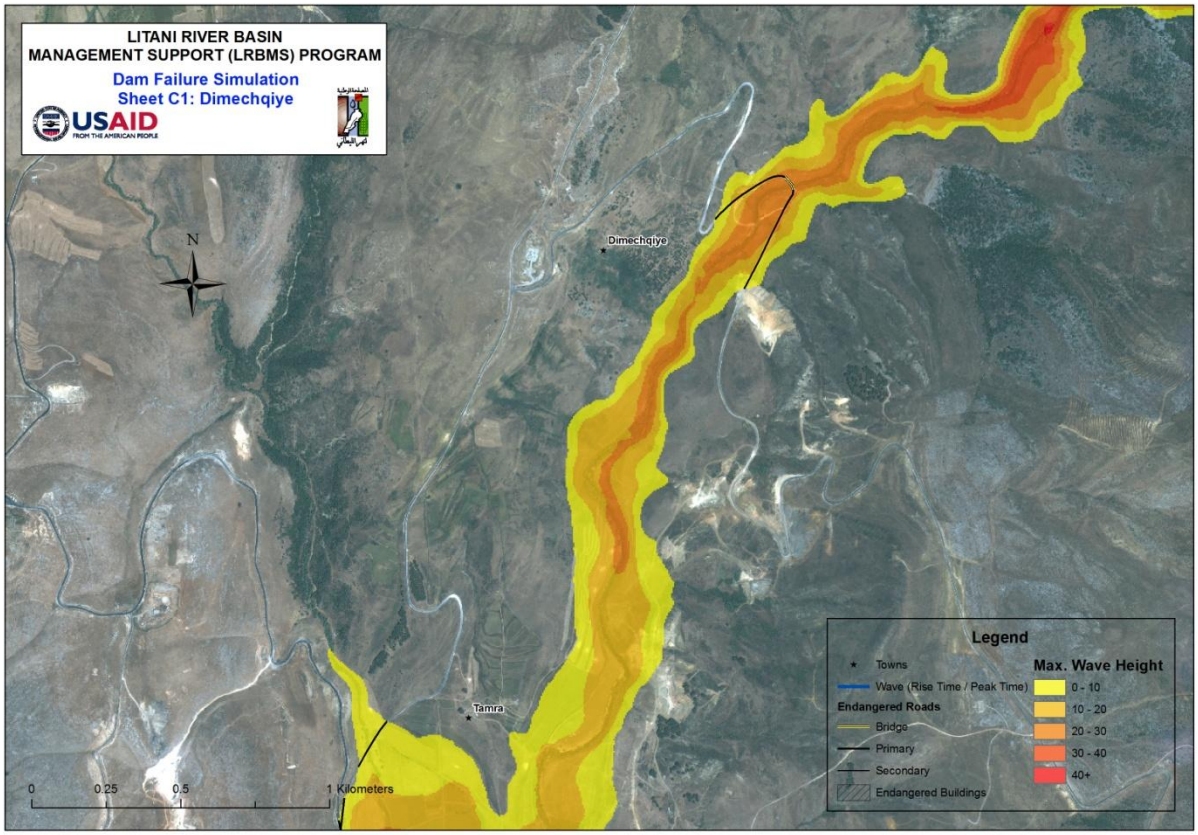
The main reference used to prepare this Emergency Action Plan is the "Federal Guidelines for Dam Safety Emergency Action Planning for Dam Owners", Federal Emergency Management Agency, Oct 1998, reprinted April 2004.

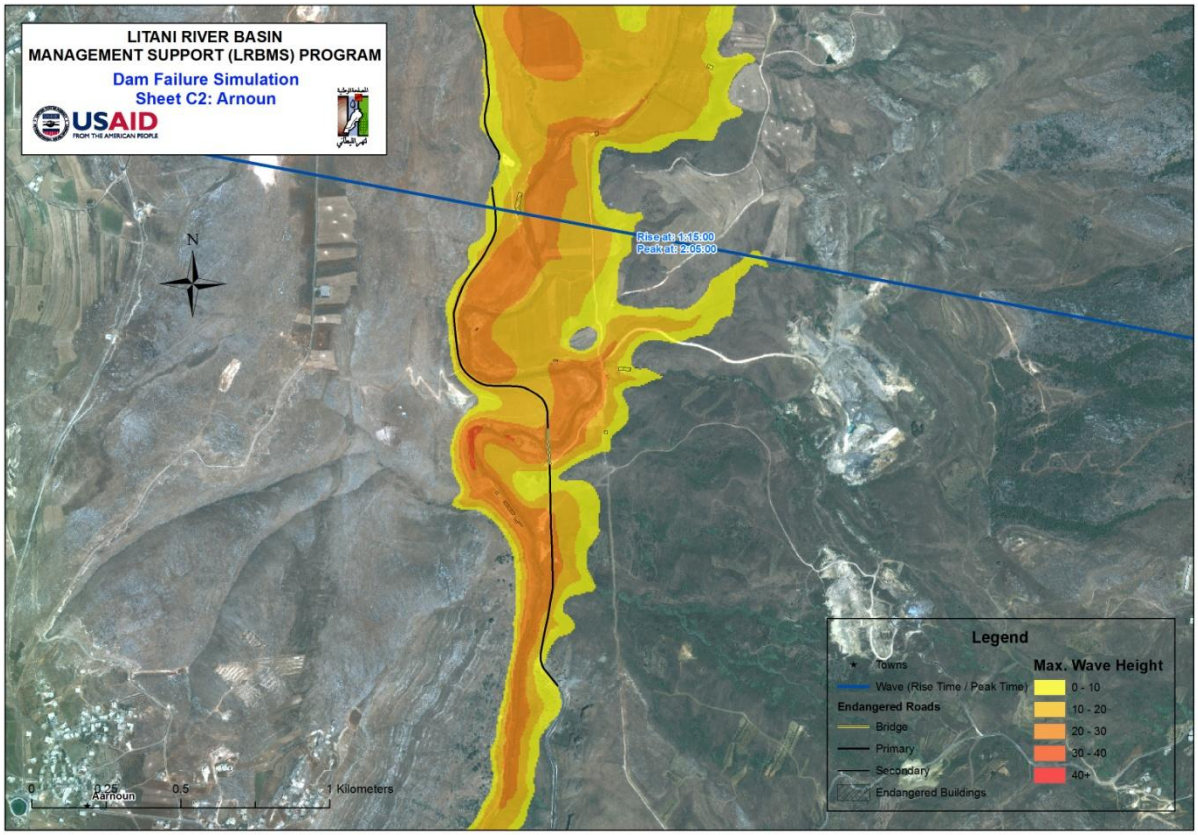
APPENDIX FLOOD MAPS

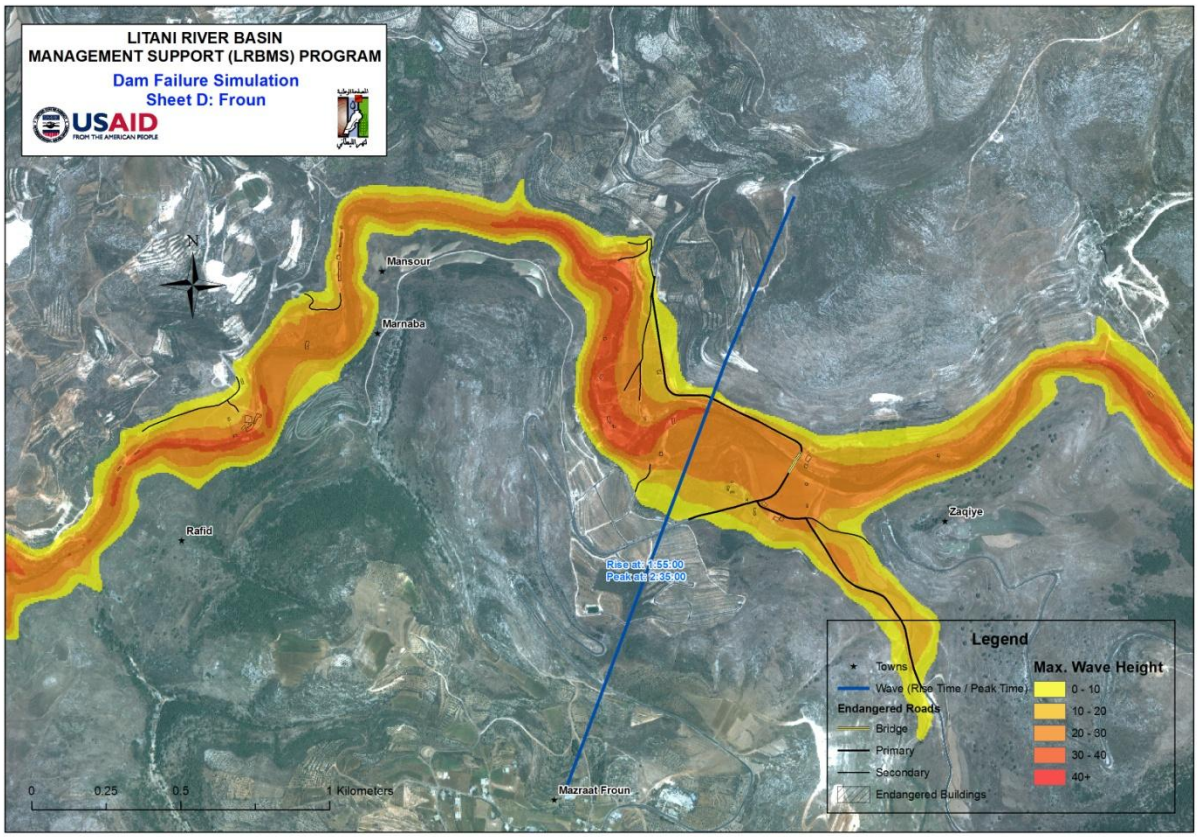


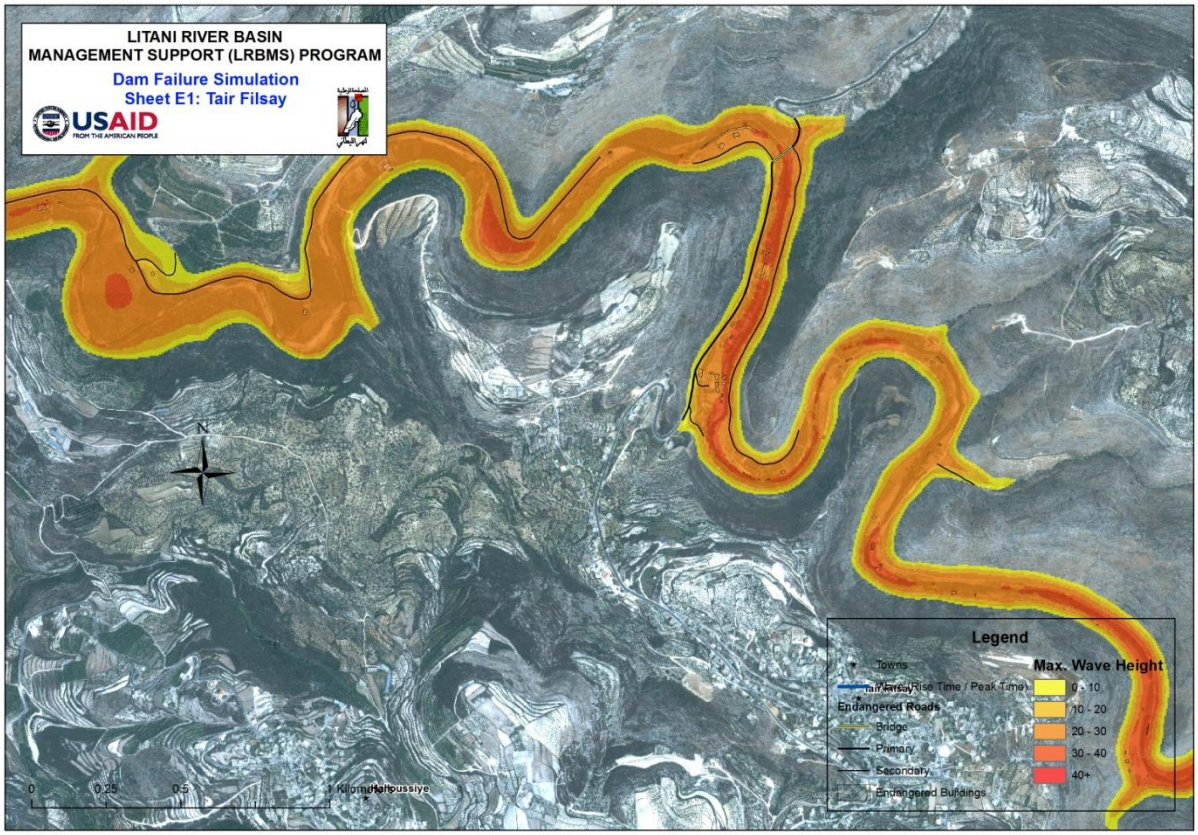

LITANI RIVER BASIN
MANAGEMENT SUPPORT (LRBMS) PROGRAM
Dam Failure Simulation
Sheet A: Mashghara-Sohmor
USAID
FROM THE AMERICAN PEOPLE
Rise at: 0:0:00
Peak at: 1:25:00
N
Rise at: 0:25:00
Peak at: 1:35:00
Sohmor
0
0.25
0.5
1 Kilometers
Legend
Towns
Wave (Rise Time / Peak Time)
Endangered Roads
Bridge
Primary
Secondary
Endangered Buildings
Max. Wave Height
0 - 10
10 - 20
20 - 30
30 - 40
40+

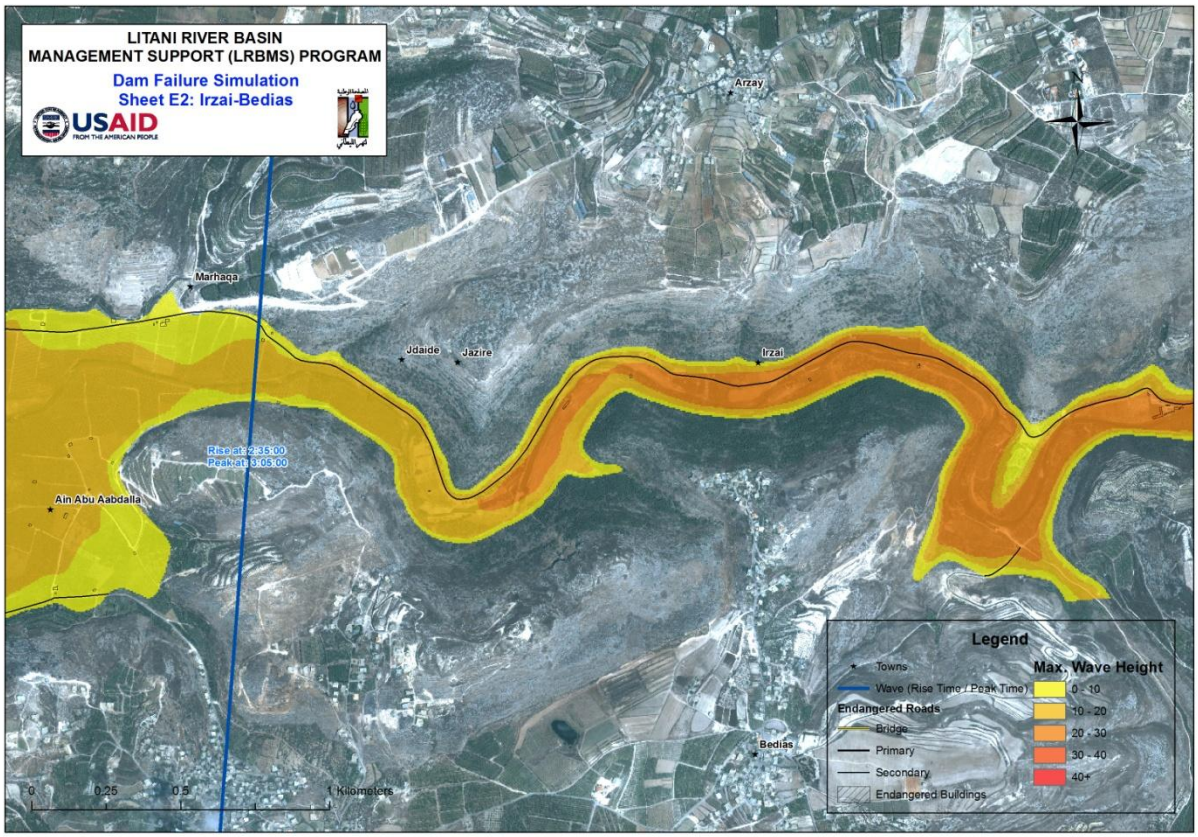

LITANI RIVER BASIN
MANAGEMENT SUPPORT (LRBMS) PROGRAM
Dam Failure Simulation
Sheet B: Yohmor
USAID
FROM THE AMERICAN PEOPLE
N
Yohmor
Rise at: 0:40:00
Peak at: 1:35:00
Legend
Towns
Wave (Rise Time / Peak Time)
Endangered Roads
Bridge
Primary
Secondary
Endangered Buildings
Max. Wave Height
0 - 10
10 - 20
20 - 30
30 - 40
40+
0
0.25
0.5
1 Kilometers

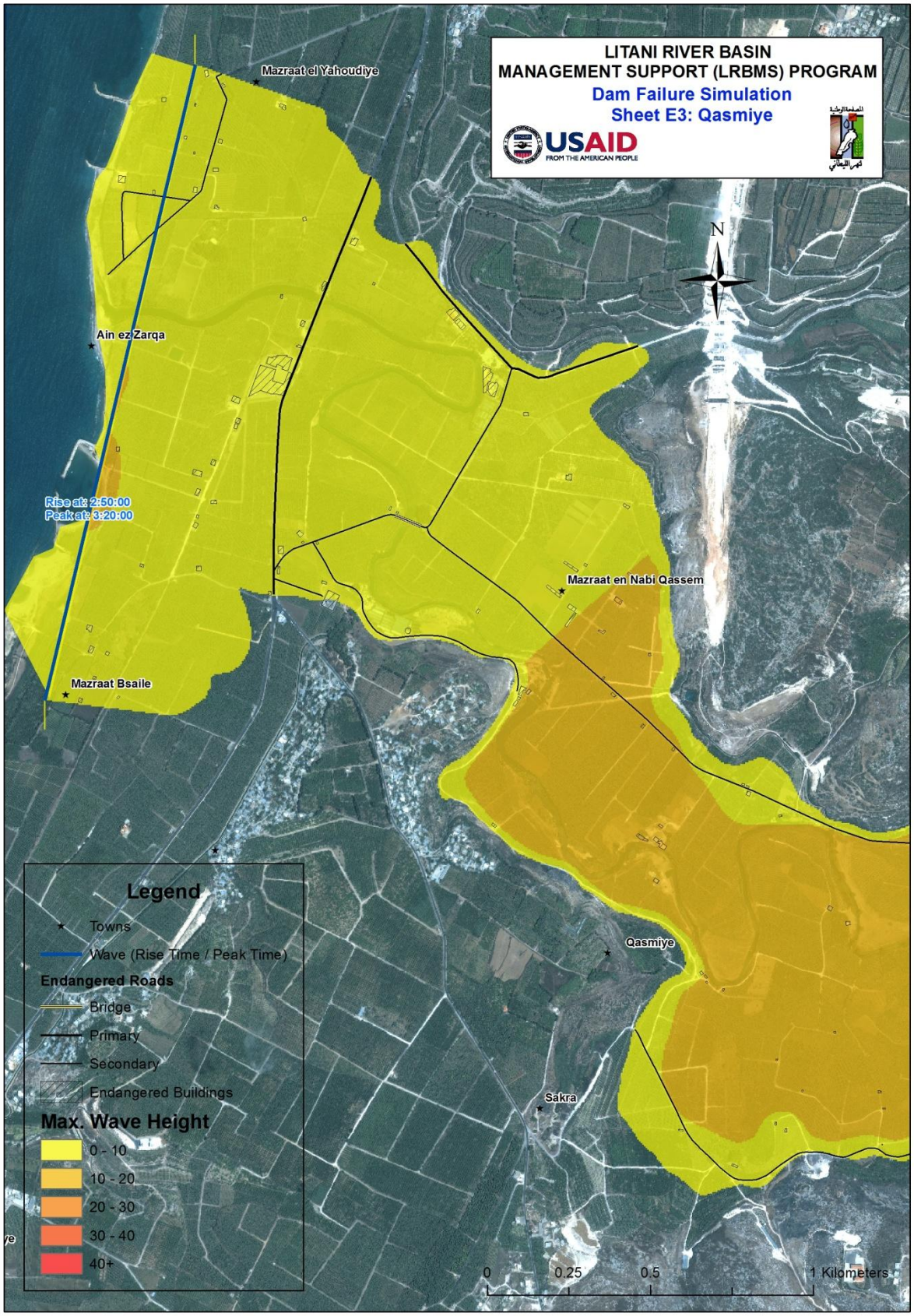

LITANI RIVER BASIN
MANAGEMENT SUPPORT (LRBMS) PROGRAM
Dam Failure Simulation
Sheet C1: Dimechqiye
USAID
FROM THE AMERICAN PEOPLE
N
Dimechqiye
Tamra
0
0.25
0.5
1 Kilometers
Legend
Towns
Wave (Rise Time / Peak Time)
Endangered Roads
Bridge
Primary
Secondary
Endangered Buildings
Max. Wave Height
0 - 10
10 - 20
20 - 30
30 - 40
40+


LITANI RIVER BASIN
MANAGEMENT SUPPORT (LRBMS) PROGRAM
Dam Failure Simulation
Sheet C2: Arnoun
USAID
FROM THE AMERICAN PEOPLE
N
Rise at: 1:15:00
Peak at: 2:05:00
Legend
Towns
Wave (Rise Time / Peak Time)
Endangered Roads
Bridge
Primary
Secondary
Endangered Buildings
Max. Wave Height
0 - 10
10 - 20
20 - 30
30 - 40
40+
0
0.25
0.5
1 Kilometers
Aarnoun


LITANI RIVER BASIN
MANAGEMENT SUPPORT (LRBMS) PROGRAM
Dam Failure Simulation
Sheet D: Froun
USAID
FROM THE AMERICAN PEOPLE
N
Mansour
Marnaba
Rafid
Zaqiye
Rise at: 1:55:00
Peak at: 2:55:00
Mazraat Froun
0
0.25
0.5
1 Kilometers
Legend
Towns
Wave (Rise Time / Peak Time)
Endangered Roads
Bridge
Primary
Secondary
Endangered Buildings
Max. Wave Height
0 - 10
10 - 20
20 - 30
30 - 40
40+


LITANI RIVER BASIN
MANAGEMENT SUPPORT (LRBMS) PROGRAM
Dam Failure Simulation
Sheet E1: Tair Filsay
USAID
FROM THE AMERICAN PEOPLE
N
Legend
Towns
Tair Filsay
Rise Time / Peak Time
Endangered Roads
Bridge
Primary
Secondary
Endangered Buildings
Max. Wave Height
0 - 10
10 - 20
20 - 30
30 - 40
40+
0
0.25
0.5
1 Kilometers
Hafroussiye


LITANI RIVER BASIN
MANAGEMENT SUPPORT (LRBMS) PROGRAM
Dam Failure Simulation
Sheet E2: Irzai-Bedias
USAID
FROM THE AMERICAN PEOPLE
Arzay
Marhaqa
Jdaide
Jazire
Irzai
Rise at 12:35:00
Peak at 13:05:00
Ain Abu Aabdalla
Bedias
0 0.25 0.5 1 Kilometers
Legend
Towns
Wave (Rise Time / Peak Time)
Endangered Roads
Bridge
Primary
Secondary
Endangered Buildings
Max. Wave Height
0 - 10
10 - 20
20 - 30
30 - 40
40+


LITANI RIVER BASIN
MANAGEMENT SUPPORT (LRBMS) PROGRAM
Dam Failure Simulation
Sheet E3: Qasmiye
USAID
FROM THE AMERICAN PEOPLE
N
Mazraat el Yahoudiye
Ain ez Zarqa
Rise at: 2:50:00
Peak at: 3:20:00
Mazraat en Nabi Qassem
Mazraat Bsaile
Qasmiye
Sakra
Legend
Towns
Wave (Rise Time / Peak Time)
Endangered Roads
Bridge
Primary
Secondary
Endangered Buildings
Max. Wave Height
0 - 10
10 - 20
20 - 30
30 - 40
40+
0
0.25
0.5
1 Kilometers

U.S. Agency for International Development
1300 Pennsylvania Avenue, NW
Washington, DC 20523
Tel: (202) 712-0000
Fax: (202) 216-3524
www.usaid.gov