



Landslide Early Warning System and its ISO Proposal

Teuku Faisal Fathani, Ph.D.

Dr. Eng. Wahyu Wilopo

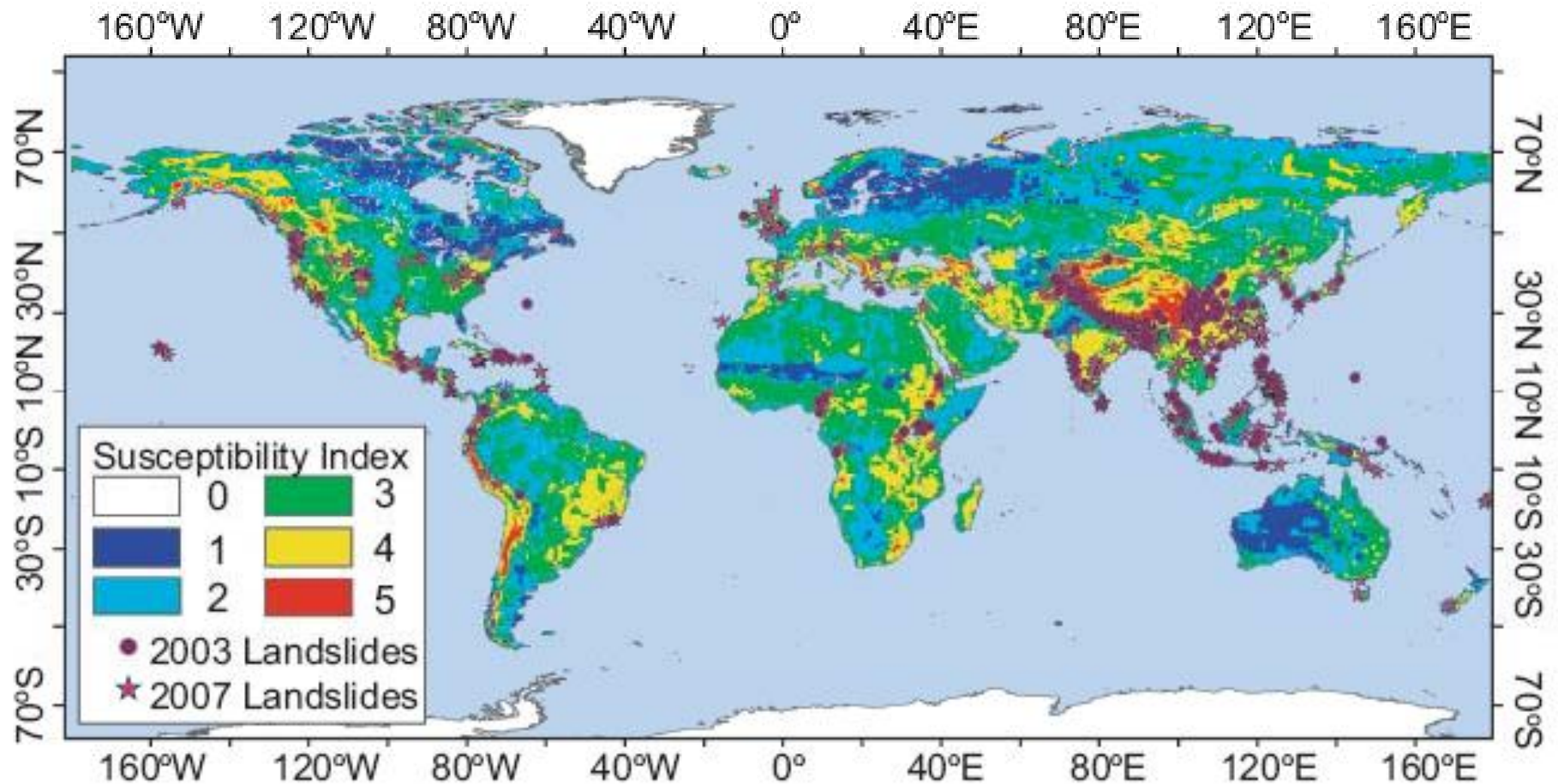
Universitas Gadjah Mada, INDONESIA

Asian Conference on Disaster Reduction 2016, Phuket, 25-26 February 2016

Outline

-
- Background (Sendai Framework of Action), objectives, users
 - Existing Guideline/Standard on Landslide EWS
 - Basic concept: Socio-technical integration
 - 4 key-element by UN-ISDR (2006) and 7 Sub-systems of Landslide EWS
 - Implementation of 7 Sub-system of Landslide EWS
-

Landslide susceptibility map



International Consortium on Landslides

- Established in 2001, active members from more than 50 countries
- ICL Supporting Organizations
 - [The United Nations Educational, Scientific and Cultural Organization \(UNESCO\)](#)
 - [The World Meteorological Organization \(WMO\)](#)
 - [The Food and Agriculture Organization of the United Nations \(FAO\)](#)
 - [The United Nations International Strategy for Disaster Reduction Secretariat \(UNISDR\)](#)
 - [The United Nations University \(UNU\)](#)
 - [The International Council for Science \(ICSU\)](#)
 - [The World Federation of Engineering Organizations \(WFEO\)](#)
 - [The International Union of Geological Sciences \(IUGS\)](#)



Background

- It is difficult to relocate community (peoples) living in landslide vulnerable area. The most effective DRR effort is to improve the **community's preparedness by implementing EWS**.
 - Warning system which mainly emphasize on technical approach mostly does not work properly due to lack of community awareness with result in poor maintainance and operation.
 - Improve community preparedness and willingness to protect themselves from landslide disasters.
 - Integration of **technical and social system** is required to support the community empowerment program for DRR in landslide vulnerable area.
-

Background (cont.)

- EWS implementation in the world is in line with the 2015-2030 **Sendai Framework for Action** with four (4) priorities in DRR :

1. Understand disaster risk
2. Strengthen disaster risk governance to manage disaster risk
3. Invest in DRR for resilience
4. Invest in disaster preparedness to enhance response

“The improvement of preparedness in order to respond effectively to a disaster, by implementing a simple, low-cost EWS and improving the dissemination of information about EWS of natural disasters at local and national levels.”

- Referring to the **four key elements** of community-based EWS (UN-ISDR, 2006), therefore it is necessary to develop a standardization for landslide EWS
-



Objectives

- Establishing an International Standard for the implementation of landslide EWS, by Integrating technical and social networks
- Reducing risk from landslide disasters by increasing the community awareness – preparedness - resilience
- Community empowerment with respect to community-based disaster risk reduction in landslide vulnerable area


Users

- International organization/institution
 - Central and local government authority
 - Private sectors, NGOs
 - Local community
-



ISO Draft: Landslide Early Warning System

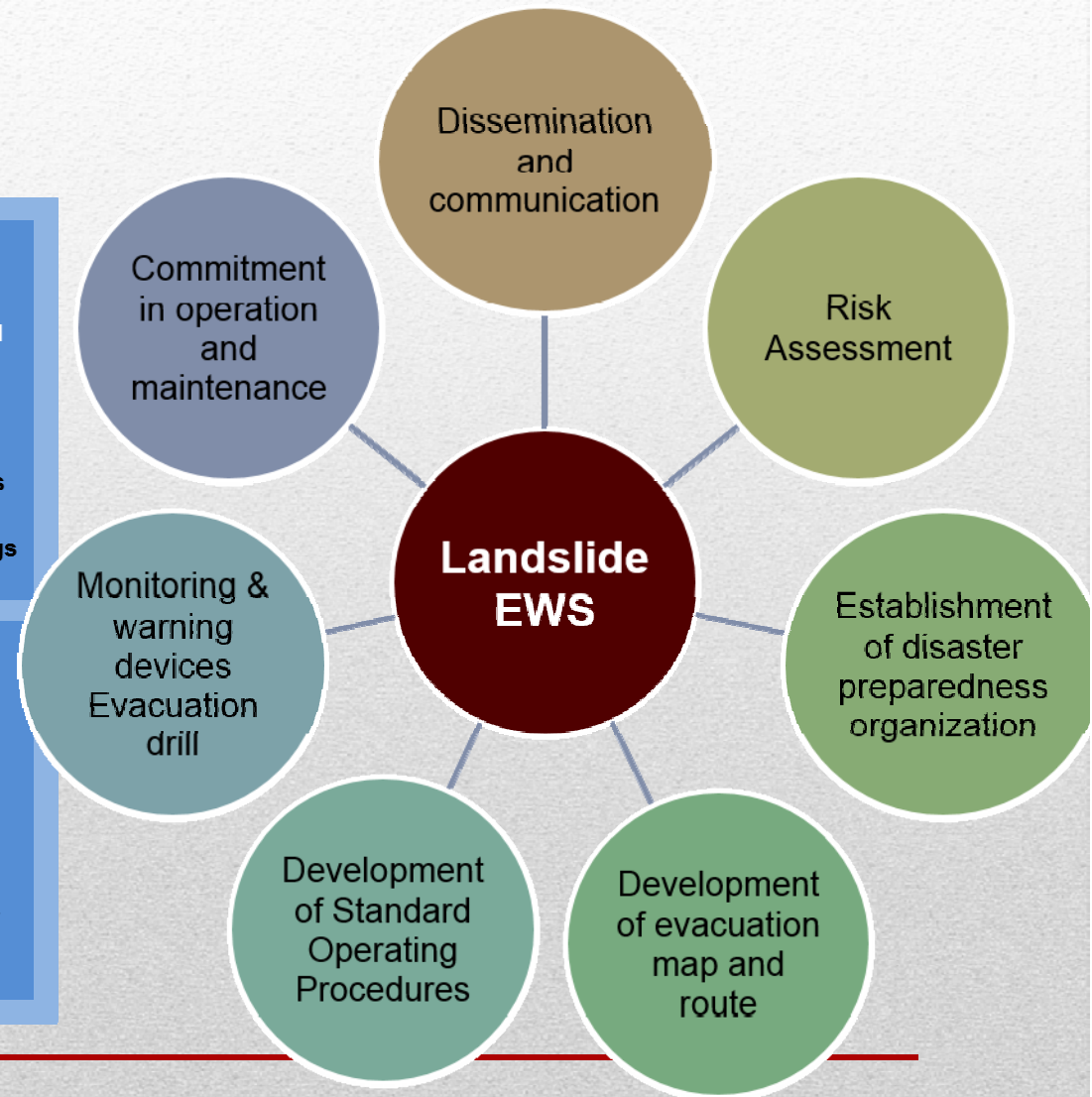
SECTION	CONTENT
Scope	Specifies the requirement for a landslide early warning system
Abbreviations, definitions and terms	For the purpose of the document, definition of terms/abbreviation are needed
Seven sub-systems of landslide early warning system	Specifies all parts of the landslide sub-systems in detail
Appendices (Informative)	Appendices as explanation for the guidelines



4 key element for community-based EWS (UN-ISDR, 2006)

<p>RISK KNOWLEDGE</p> <p>Systematically collect data and undertake risk assessments</p> <p>Are the hazards and the vulnerabilities well known?</p> <p>What are the patterns and trends in these factors?</p> <p>Are risk maps and data widely available?</p>	<p>MONITORING & WARNING DEVICE</p> <p>Develop hazard monitoring and early warning services</p> <p>Are the right parameters being monitored?</p> <p>Is there a sound scientific basis for making forecasts?</p> <p>Can accurate and timely warnings be generated?</p>
<p>DISSEMINATION & COMMUNICATION</p> <p>Communicate risk information and early warnings</p> <p>Do warnings reach all of those at risk?</p> <p>Are the risks and warnings understood?</p> <p>Is the warning information clear and useable?</p>	<p>RESPONSE CAPABILITY</p> <p>Build national and community response capabilities</p> <p>Are response plans up to date and tested?</p> <p>Are local capacities and knowledge made use of?</p> <p>Are people prepared and ready react to warnings?</p>

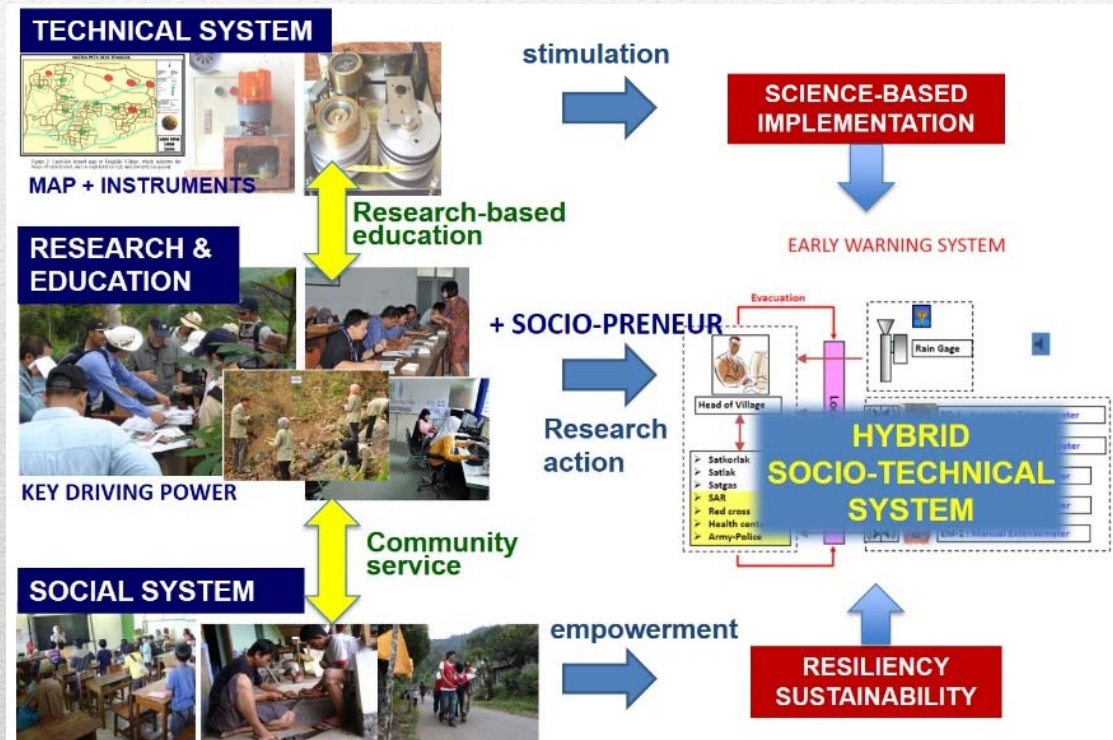
7 Sub-systems of Landslide EWS



Basic Concept in Proposing Seven Sub-systems of Landslide EWS

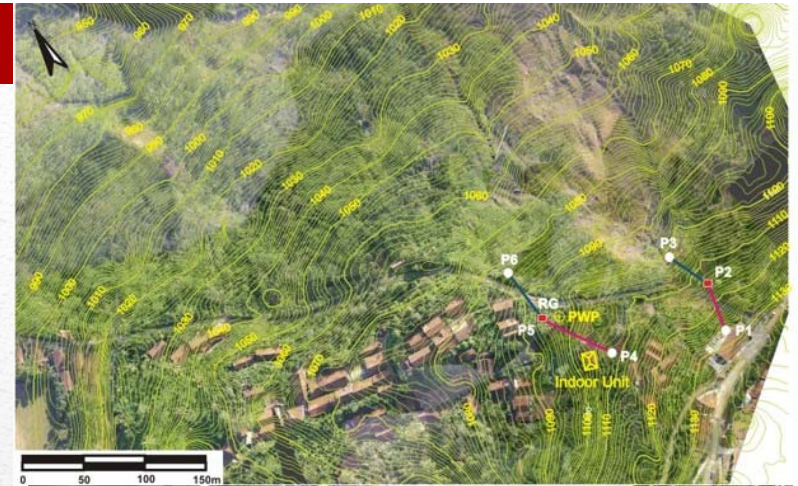
Basic Concept:

- ① Integration between technical and social systems
“Human and Technical Sensor”
- ② Sustainable Guarantee
 - Community empowerment through Disaster Preparedness Team
 - Commitment among research & education-government-community-private sector
- ③ Sustainable Innovation
 - Three level generation
 - 3 in 1 Approach: Education-Research-Community Development and Empowerment



Risk Assessment

- **Technical survey** on geological conditions to determine landslide susceptibility and stable zones.
- **Institutional survey** to understand whether an established institution exist to monitor and mitigate landslide hazards in the disaster-prone areas.
- **Social survey** to understand the community's understanding of landslide hazards.



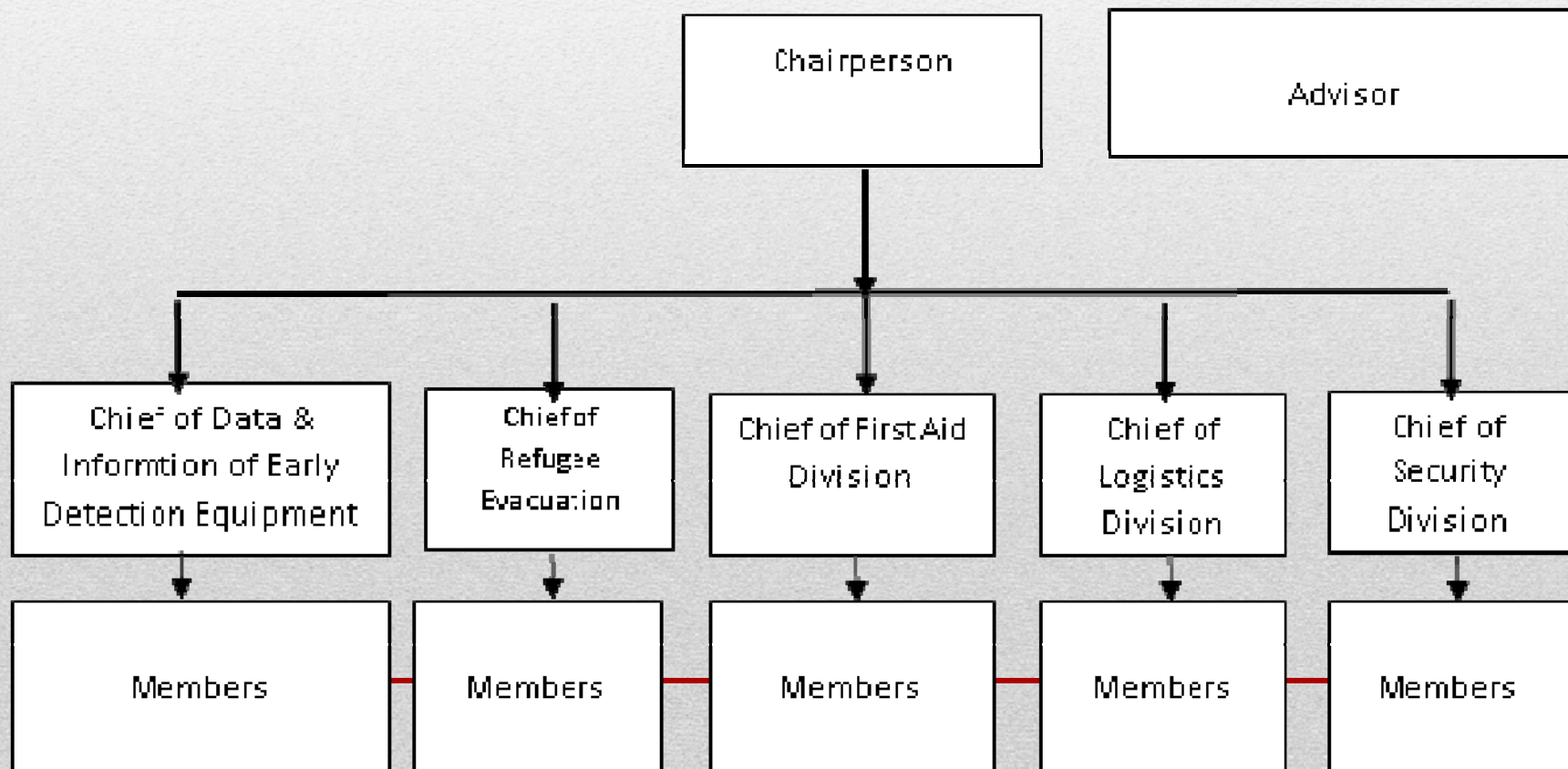
Dissemination

- Methods and materials of the dissemination are tailored based on the preliminary data of the risk assessments
- The community could understand the landslide mechanisms, symptoms, and how to minimize risks
- Identifying the key people who have a strong commitment as forerunners in the establishment of disaster preparedness team.



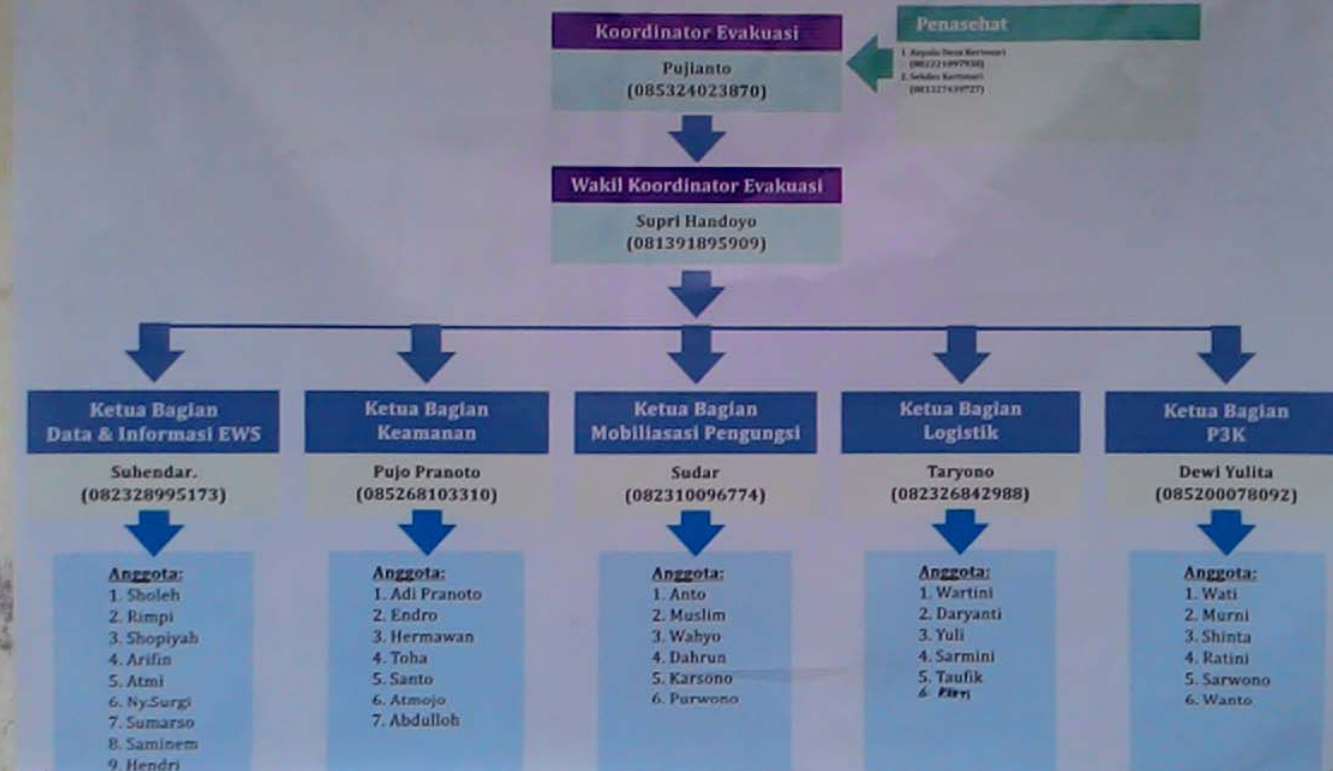
Establishment of disaster preparedness and response team

- In charge of determining landslide risk zones and evacuation routes and mobilizing people to evacuate before the landslide occur.
- Responsible for operating and maintaining monitoring tools



ORGANISASI SIAGA BENCANA

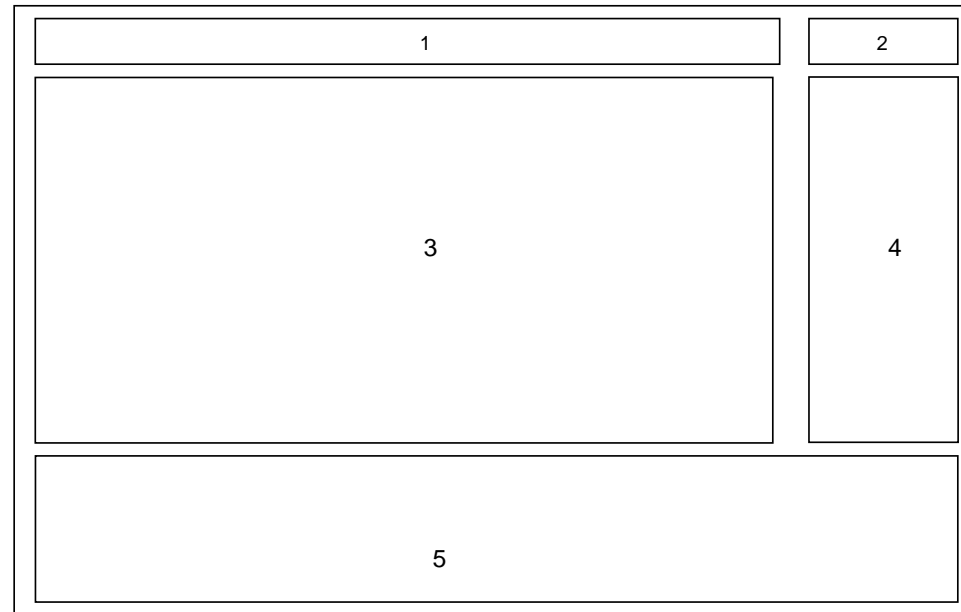
DUSUN KEBAKALAN, DESA KERTOSARI, KECAMATAN KALI BENING, KAB. BANJARNEGARA



Disaster Preparedness Organization
Dusun Kebakalan, Desa Kertosari, Kec. Kalibening - Banjarnegara

Development of evacuation routes and maps

- An evacuation map includes landslide risk zones and evacuation routes, which provide information on the safe and unsafe zones against landslide hazard, safe evacuation routes for the residents to evacuate, as well as secure locations (assembly point).
 - Maps need to be made simply so that it is easier to understand by the local community.
-



Description:

1. Title of the evacuation map indicating the installation location of the landslide early detection equipment;
2. Logo of the stakeholders or the local authorities;
3. Ground plan of the evacuation routes;
4. Legend and important information (landmarks) and common signs easily recognizable by the public such as mosques, schools, offices, etc.;
5. Name of the heads of the families, distinguished by RT/RW (neighborhood/community association).

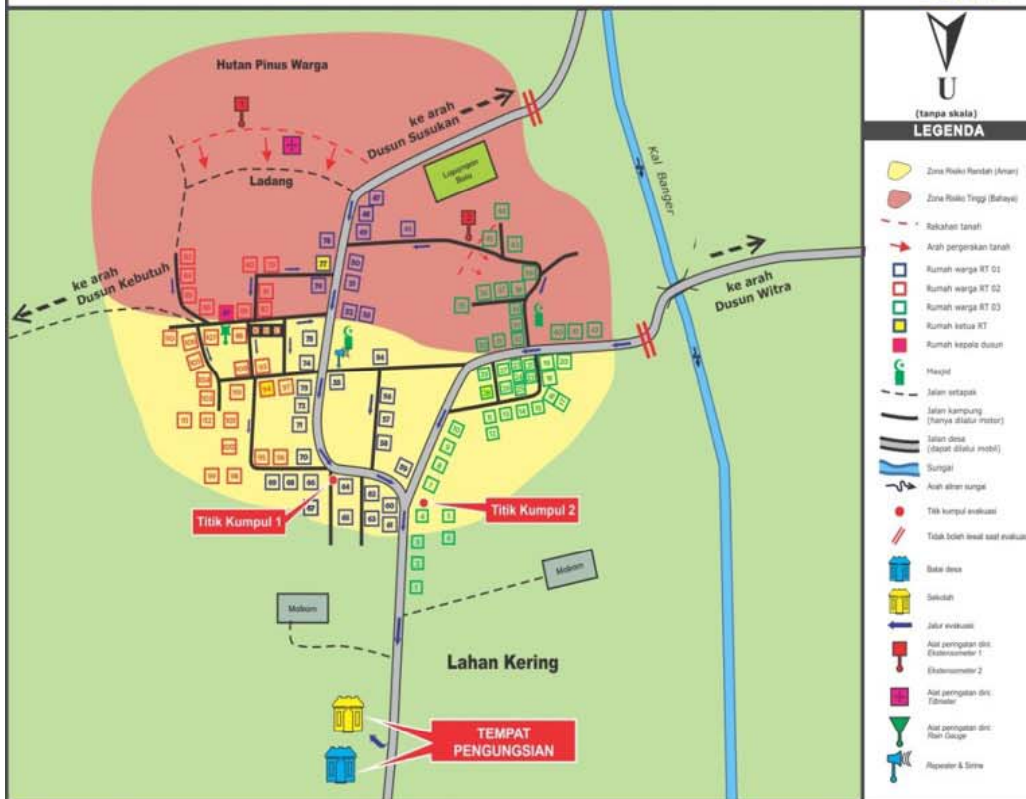
NOTE 1 The ground plan does not need to include the scale, but only the north direction that can be placed in the plan's column or in the legend. The north direction may not face up, but down, depending on the local customs.

NOTE 2 The format of the ground plan is flexible, but all elements of a ground plan should be included in it.

Ground Plan for Evacuation Map

DENAH JALUR EVAKUASI

Dusun Kebakalan, Desa Kertasari, Kec. Kalibening, Kab. Banjarnegara



- (tanya skala)
- LEGENDA**
- Zona Risiko Rendah (Aman)
 - Zona Risiko Tinggi (Bahaya)
 - Rekanan tanah
 - Arah pergerakan tanah
 - Rumah warga RT 01
 - Rumah warga RT 02
 - Rumah warga RT 03
 - Rumah ketua RT
 - Rumah kepala dusun
 - Masjid
 - Jalan setapak
 - Jalan kampung (hanya dilalui motor)
 - Jalan desa (dapat dilalui mobil)
 - Sungai
 - Arah aliran sungai
 - Titik kumpul evakuasi
 - Tidak boleh lewat saat evakuasi
 - Balai desa
 - Sekolah
 - Jalur evakuasi
 - Alat peringatan dini: Ekstensometer 1
 - Ekstensometer 2
 - Masjid
 - Jalan setapak
 - Jalan kampung (hanya dilalui motor)
 - Jalan desa (dapat dilalui mobil)
 - Sungai
 - Alat peringatan dini: Tiltmeter
 - Alat peringatan dini: Rain Gauge
 - Repeater & Sirine

DAFTAR NAMA KEPALA RUMAH TANGGA DUSUN KEBAKALAN

RT 03			RT 01			RT 02		
1. Heriyanto	16. Rukun Puji	31. Sugiyanto	46. Amin	61. Karmo	76. Muslim	79. Rosito	94. Sutikno	109. Suwiknyo
2. Darmanto	17. Imron	32. Susanto	47. Yullianto	62. Sugiarto	77. Suprihandoyo	80. Hermawan	95. Pardi	110. Samiri
3. Yanto	18. Turyanto	33. Samsudin	48. Agus	63. Alsi	78. Abidin	81. Arifin	96. Paryono	111. Dakun
4. Adi Pranoto	19. Karyono	34. Kuswanto	49. Anto	64. Jirno		82. Surono	97. Sumbani	
5. Sigit	20. Priyono	35. Miharjo	50. Abdulllah	65. Suhri		83. Marnoto	98. Rosidi	
6. Riyanto	21. Mahroji	36. Nurwanto	51. Sudiro	66. Sudar		84. Sutaryo	99. Wasri	
7. Rudi	22. Marwoto	37. Gunoto	52. Pujo Pranoto	67. Arifin		85. Sunoto	100. Soleh	
8. Ndoyo	23. Sumoto	38. Priyanto	53. Priyono	68. Harun		86. Edi Pranoto	101. Slamet	
9. Suwarno	24. Wasil	39. Karjono	54. Dakori	69. Taufik		87. Pujiyanto	102. Rohyani	
10. Sumanto	25. Sokichin	40. Suwito	55. Hansono	70. Ali		88. Yanto	103. Suniyati	
11. Subendar	26. Medi	41. Ristiyanto	56. Puji Marmo	71. Sismono		89. Sahroni	104. Karsono	
12. Tomo	27. Wiltoro	42. Matsum	57. Feri Irawan	72. Sutono		90. Junaedi	105. Kholid	
13. Ridwan	28. Arifin	43. Sutyo	58. Sumarso	73. Warung Karsinah		91. Supri	106. Hendro	
14. Tiyarjo	29. Daryanto	44. Sodikin	59. Rohadi	74. Sutoyo		92. Annul	107. Gunawan	
15. Febrli	30. Erdi	45. Hadi	60. Sungkono	75. Nurahman		93. Mitoyo	108. Purwono	

Example of Evacuation Map
Dusun Kebakalan, Desa Kertasari, Kec. Kalibening - Banjarnegara



Development of Standard Operating Procedure

- The SOP contains the procedures for responses by the disaster preparedness team and the community to the alert issued by the landslide early warning instrument.
 - The SOP was prepared based on the discussions and agreements of each division under the direction of relevant stakeholders to follow the flow of warning information delivery mechanism and evacuation commands.
-

Level of warning

LEVEL 1: CAUTION

Triggered by **rain gauge sensor**. The disaster experts should determine the critical limit for rainfall intensity that may trigger landslide in mm/hour or mm/day. If the critical limit is exceeded, then the device will give CAUTION warning.

LEVEL 2: WARNING

Triggered by **tiltmeter**. Disaster experts should determine the critical limit of soil movement in degree ($^{\circ}$)/minute or per hour, in the X-Y direction (N-S and W-E). If the instrument indicates slope inclination change that exceeds the critical limit, it will trigger the WARNING warning mechanism. **Vulnerable groups should be evacuated** first.

LEVEL 3: EVACUATE

Triggered by extensometer. This device has critical limit in mm/minutes or mm/hour, depending on the field condition determined by the disaster experts. If the movement exceeds the critical limit, the device will trigger the EVACUATE warning mechanism.

Level 1: Caution

Status/alert level	Criteria/ sign	Action/response by the community	Action by the local authority
Caution (Level 1)	<p>Criteria: determined by rainfall measurement or tremor recording</p> <p>Sign: "blue" lamps and/or siren that sounds "caution, high rainfall" or other sound signs that show the lowest threat level or alert level or depending on the local conditions</p>	<ul style="list-style-type: none"> • The team leader coordinates with the Disaster Preparedness Team. • The data and information division checks the condition of the monitoring equipment and collects data of the community, and informs the alert level and encourages preparing essential items to bring. • The Disaster Response Team provides periodic reports to the team leader. 	<ul style="list-style-type: none"> • Receives report from the disaster preparedness team leader • Checks the condition in the field and maintains coordination with the disaster preparedness team

Level 2: Warning

Status/alert level	Criteria/ sign	Action/response by the community	Action by the local authority
Warning (Level 2)	<p>Criteria: determined by increased rainfall or slope hydrology, increased tremors, and landslide indications</p> <p>Sign: "orange" lamps and siren that sounds "warning, evacuation" or other sound signs that show the increase of threat level to siaga/warning or depending on the local conditions</p>	<ul style="list-style-type: none"> • The team leader coordinates with the Disaster Preparedness Team. • The data and information division re-checks the condition of landslide and the monitoring equipment, and collects data of the community • The team leader gives the vulnerable group an order to evacuate to the assembly point, with the help of the refugee mobilization division and the security division. • The data section collects data of the vulnerable group in order to ensure that they have been evacuated. • The security division is in charge of ensuring the security of the residents' homes and the environment. 	<ul style="list-style-type: none"> • Receives report from the disaster preparedness team leader • Checks the condition in the field and maintains coordination with the disaster preparedness team • Provides support to the evacuated vulnerable group

Level 3: Evacuate

Status/alert level	Criteria/ sign	Action/response by the community	Action by the local authority
Evacuate (Level 3)	<p>Criteria: determined by increased rainfall or slope hydrology, increased tremors and rate of landslide</p> <p>Sign: "red" lamps and siren that sounds "evacuate" or other sound signs that show the highest threat level or depending on the local conditions</p>	<ul style="list-style-type: none"> • The team leader coordinates with the Disaster Preparedness Team. • The team leader gives all residents an order to evacuate to the assembly point, with the help of the refugee mobilization division and the security division. • The data and information section checks the early detection equipment and collects data of the residents in the refugee camp. 	<ul style="list-style-type: none"> • Receives report from the disaster preparedness team leader • Checks the condition in the field and maintains coordination with the disaster preparedness team • Provides emergency support to the evacuated residents

Monitoring, Early Warning, and Evacuation Drill

- Determination of the locations is based on the identification of landslide risk zones. Installation of the equipment is done with the community, aiming to increase the sense of ownership and responsibility for the equipment's condition to guarantee safety.



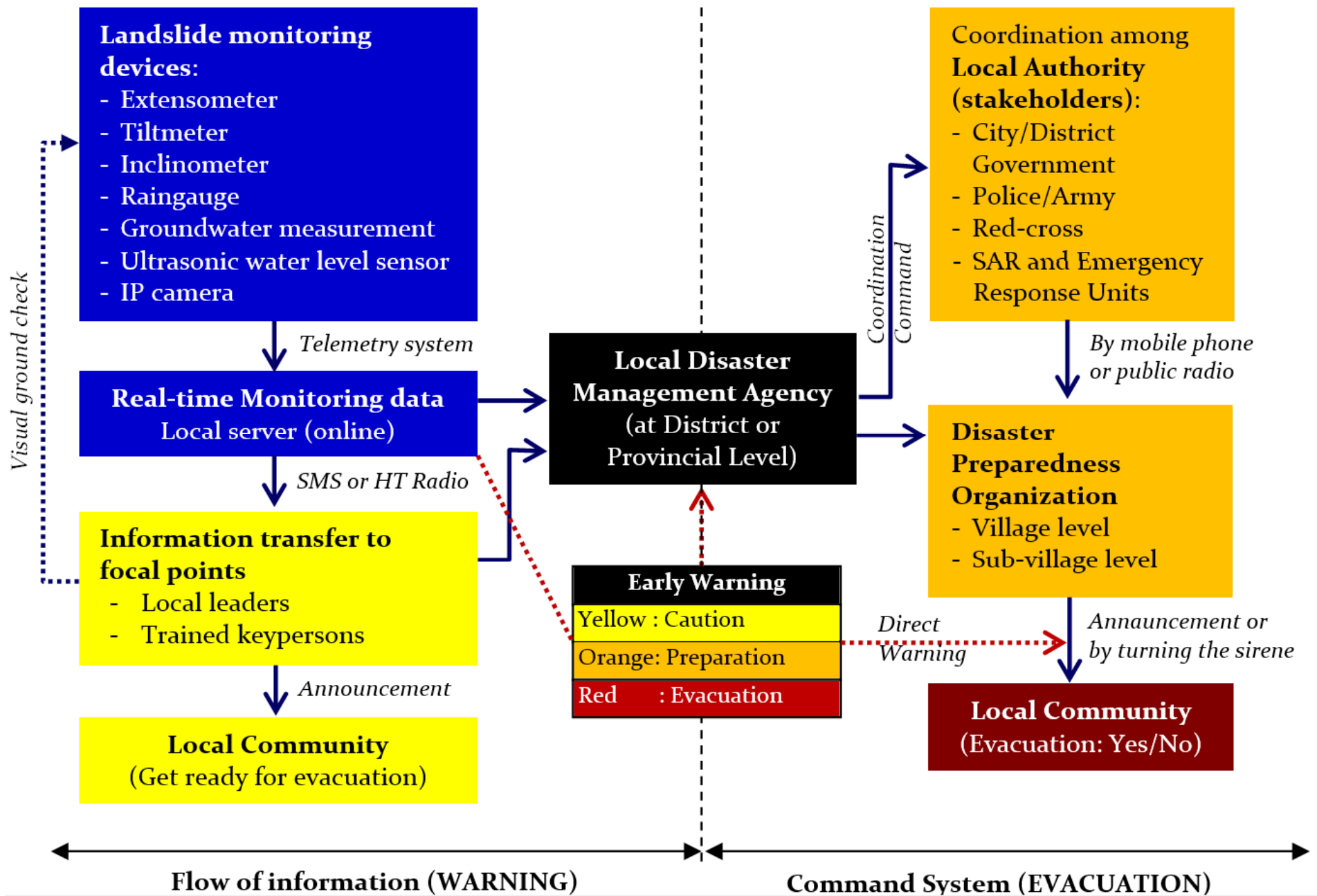


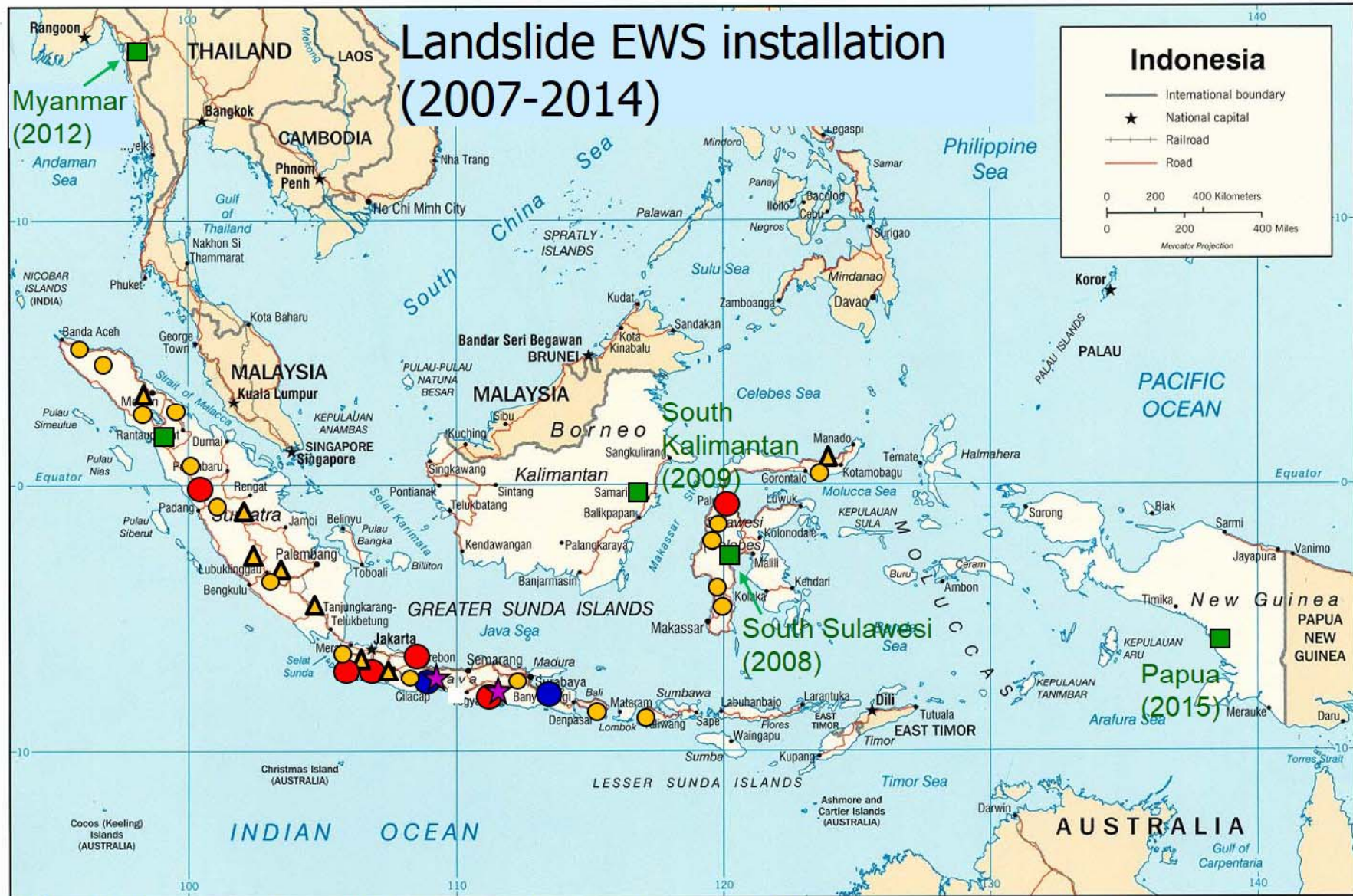
**Evacuation Drill Process
Desa Kalitlaga, Kec. Pagentan Kab. Banjarnegara**



Commitment of the local government and community on the O&M of the systems

- The commitment of the local government and the community is crucial in the operation and maintenance of the early warning system, so that all activity stages included in the SOP run well.
 - The duty and responsibility in terms of ownership, installation, operation, maintenance, and security of an early warning system are adjusted to the condition in each location and are agreed upon by the government, the community, and the private sector.
-





- UGM in cooperation with Ministry for the Development of Disadvantage Regions (KPDT)
- UGM in cooperation with National Agency for Disaster Management (BNPB) and BPBD
- BNPB 2015
- UGM in cooperation with Private Mining Company
- ▲ UGM in cooperation with Pertamina Geothermal Energy (2013)
- ★ UGM in cooperation with International Consortium on Landslides (ICL-UNESCO)

Base 802898A1 (C00429) 11-02