Surveys and Research Conducted by the NILIM in the Wake of the 2011 Great East Japan Earthquake

1. Outline of Studies and Activities

(1) Actions that the NILIM has taken in response to the 2011 Great East Japan Earthquake

Immediately after the onset of the 2011 Great East Japan Earthquake, the National Institute for Land and Infrastructure Management (NILIM), in cooperation and collaboration with the Public Works Research Institute (PWRI), Building Research Institute (BRI), and Port and Airport Research Institute (PARI), dispatched a total of 262 staff members (592 man-days) to the disaster sites as the Technical Emergency Control Force (TEC-Force) to provide technical support for emergency responses. In addition to the dispatch as the TEC-Force, the NILIM conducted a voluntary survey of damage in the affected areas.

Photo 1 Structures and buildings surveyed for damage

In January 2013, the NILIM compiled the series of disaster responses and the direction of research into new issues that emerged from the disaster experience and published them as *Initiatives of the National Institute for Land and Infrastructure Management in Response to the 2011 Great East Japan Earthquake - Record of Activities in Emergency Response and Technical Assistance for Restoration and Recovery* - The NILIM Report No. 52.

Since then, the NILIM has reflected the results of surveys and research initiated in response to the 2011 Great East Japan Earthquake in fieldwork and policies. These activities have been published in the form of research materials, papers, etc. Still, we believe that it is also meaningful to present a systematic overview of the entire research that the NILIM has taken a leading role in conducting in response to the 2011 Great East Japan Earthquake. We thus published *A Complete Record of the Five-year Research Conducted by the National Institute for Land and Infrastructure Management in Response to the 2011 Great East Japan Earthquake*, the NILIM Research Report No. 57, in September 2016.

(2) Overall picture of the research

Figure 1 is a bird's-eye view diagram, which shows the development and relationship of the survey and research by extracting main items, categorizing the activities, and connecting them with arrows and lines. Figure 2 shows the concept of creating the diagram.

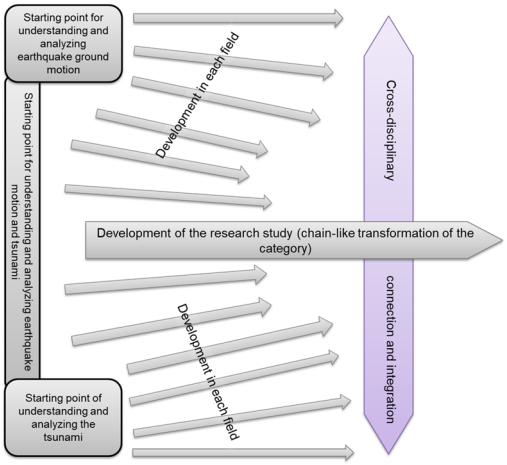

Figure 2 Concept of creating an overall bird's-eye view diagram

Figure 1 shows how various fields of investigation and research were developed from left to right, starting from the analysis of understanding earthquake motion at the upper left end and understanding tsunami attack at the lower left end. When viewed vertically, the diagram shows the sequence of fields. Roughly, from top to bottom.

- Landslides, dams, road structures, river structures (mainly levees), residential land, various buildings <damaged mainly by earthquake motion>
- Sewerage facilities, damage to urban areas in general, providing housing for disaster victims, airports, port facilities (including breakwaters), drifting debris, port-related logistics <damaged by earthquake motion and tsunami>
- Parks and green areas, coastal protection facilities (types that cover embankment, seawalls, revetments), landscapes and historic urban areas, etc. <mainly damaged by tsunami>

A series of research studies covered the above areas.

Figure 3 shows the typical pattern of relationships identified in the development of the categorized research activities in Figure 1. In the series of research activities, the diagram starts with understanding and analyzing the events that caused the earthquake disasters. The results of this study are then summarized as assessing the actual damage, analysis, mechanism study / data archiving. Based on the

knowledge obtained from this research, the research led to the development of hazard prediction and hazard evaluation methods and external force setting methods and standards to estimate damages and external forces expected in the future. It was also expanded to developing design standards for structures and development of new construction methods and techniques to prevent and reduce damage through proactive technical responses to estimated external forces. In addition, in order to contribute to early post-disaster recovery and reconstruction, research and studies are being developed toward the establishment of procedures, plans, and frames for recovery and reconstruction. The star (★) mark, which indicates that research results have been explicitly reflected in such measures as technical standards and guidelines, is frequently found at the exit part of the routine development above. This indicates that the research has been developed, and many research results became available for implementation. In addition, although the above trend was not clearly recognized, we also engaged in research that can be categorized into understanding the actual conditions of emergency response, recovery, and restoration, disaster recognition methods, and disaster response management methods that lead to the spread of disaster prevention and mitigation.

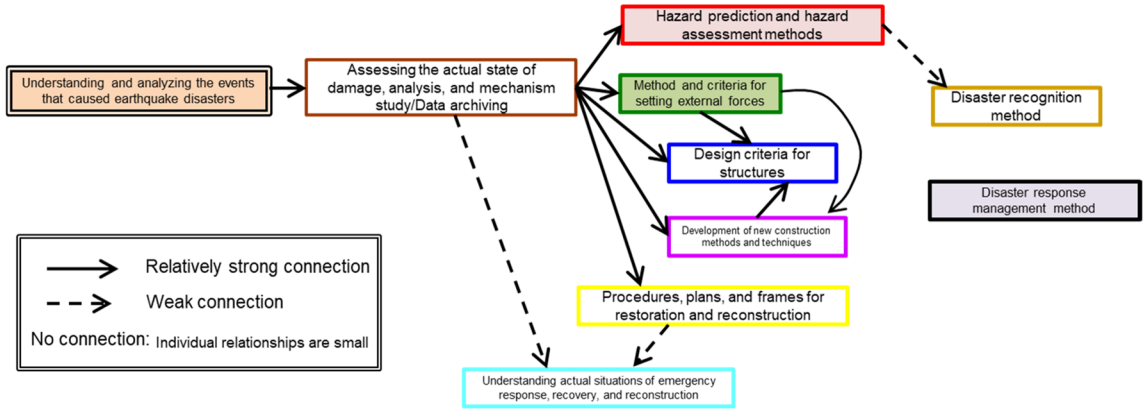

Figure 3 Typical patterns of category development in research implementation

(3) Specific examples of research results

Among the research items shown in Figure 1, this paper discusses the following items:

① Improvement of the method of setting the rainfall standard for issuing landslide warnings and evacuation orders after an earthquake

Research on establishing provisional standards for post-earthquake landslide warning information (See "Landslide Disaster Warning Information and the Development of Technology to Support the Policy Implementation" on page 86.)

② Development of technologies and the provision of tools to support the restoration and recovery of liquefaction-damaged areas (urban areas) →

Development of a simplified evaluation sheet for the effectiveness of the lattice underground wall construction method (See "Measures against Liquefaction of Residential Lots" on page 50.)

③ Study of the improvement of earthquake resistance for sewer pipelines → Reflected in "Sewerage Facility Earthquake Resistance Guideline and its Descriptions"

(See "Investigation of Sewerage Facility Disasters and Improvement of Countermeasures" on page 22.)

④ Proposal for a resilient coastal embankment structure (a type that covers embankment) →

Research on seawalls that are resilient against tsunami (See "Research on comprehensive tsunami countermeasures combining tangible and intangible measures" on page 30.)

⑤ Study of structural requirements for tsunami evacuation buildings →

Structural design method for tsunami evacuation buildings (See "Ensuring Safety and Security of Building Structures" on page 44.)

2. List of related reports and technical documents

1) Research Report of NILIM No. 52: *Emergency Responses and Engineering Contributions by NILIM for the Recovery from the 2011 Great East Japan Earthquake - January 2013* http://www.nilim.go.jp/lab/bcg/siryou/rpn/rpn0052.htm

2) Research Report of NILIM No. 57: *Compilation of Research Results over 5 years (FY2011-2015) by NILIM to Contribute Toward Reconstruction Following the Great East Japan Earthquake*

September 2016 http://www.nilim.go.jp/lab/bcg/siryou/rpn/rpn0057.htm

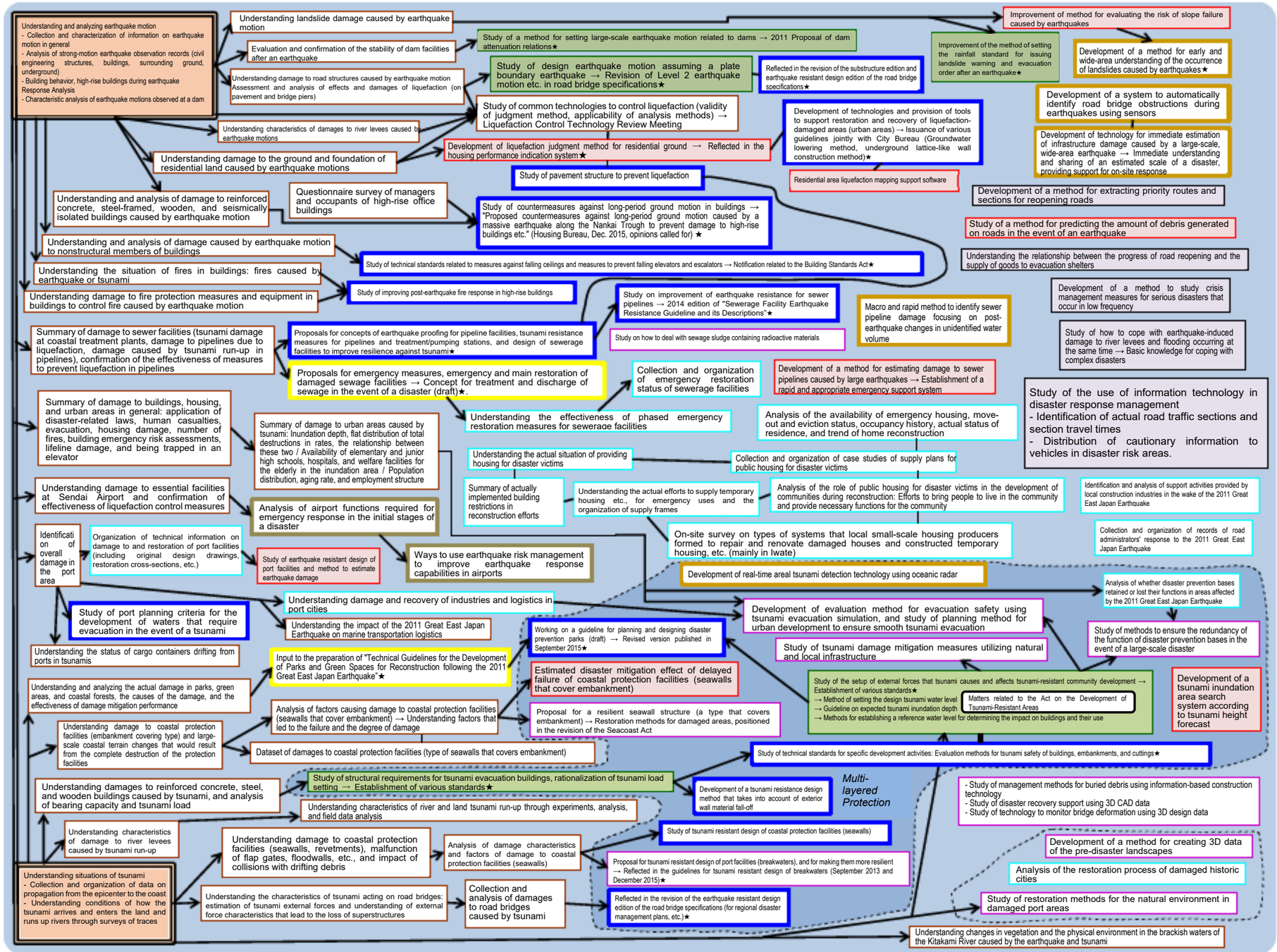

Figure 1 Development of categorized research activities

1. Research and development that supports policies on land and infrastructure technologies