GIROJ᾽s Earthquake Loss Model

Earthquake insurance in Japan （for householders）

- **Insurable property**
  - □ Limited to buildings for residential （including condos） use and/or movables for living （household goods）.
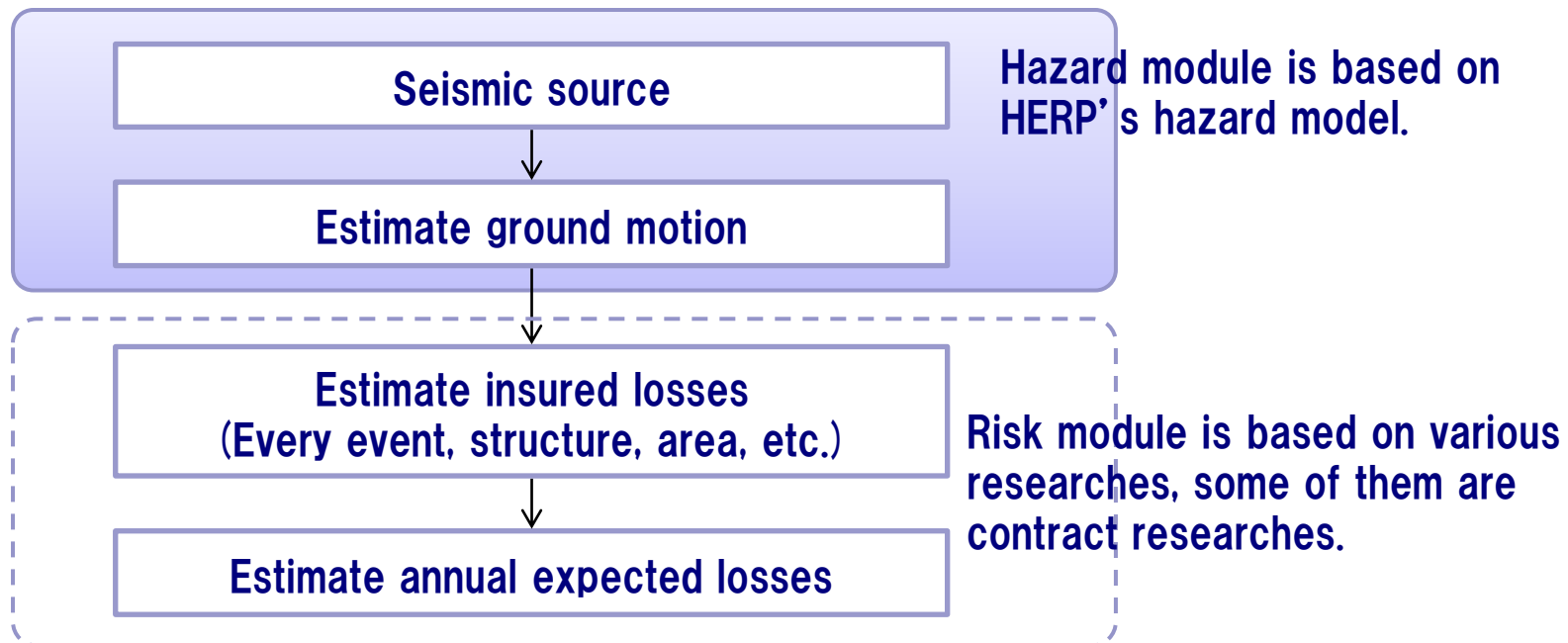
- **Losses to be covered**
  - □ Losses due to fire, destruction, burial and flood directly or indirectly caused by earthquakes, volcanic eruptions and tsunami.

- **Payment patterns of insurance claims**
  - □ Insured properties damaged by earthquakes are investigated and classified into following 4 categories.
    - Total loss　　　　　　　　（100% of insured amount will be paid.）
    - Large half loss　　　　　　（60%）
    - Small half loss　　　　　　（30%）
   - Partial loss　　　　　　　（5%）

Our Earthquake Risk Model for Rating

- **Our earthquake risk model consists of two major modules. One is estimating hazard, and the other is calculating risk.**
  - □ The hazard simulation module is based on the method of National Seismic Hazard Map made by Headquarters for Earthquake Research Promotion (HERP).
  - □ The risk calculation module builds up with many sub-modules (reflecting outcomes of contract researches and others).

Seismic source

↓

Estimate ground motion

Hazard module is based on HERP's hazard model.

↓

Estimate insured losses (Every event, structure, area, etc.)

↓

Estimate annual expected losses

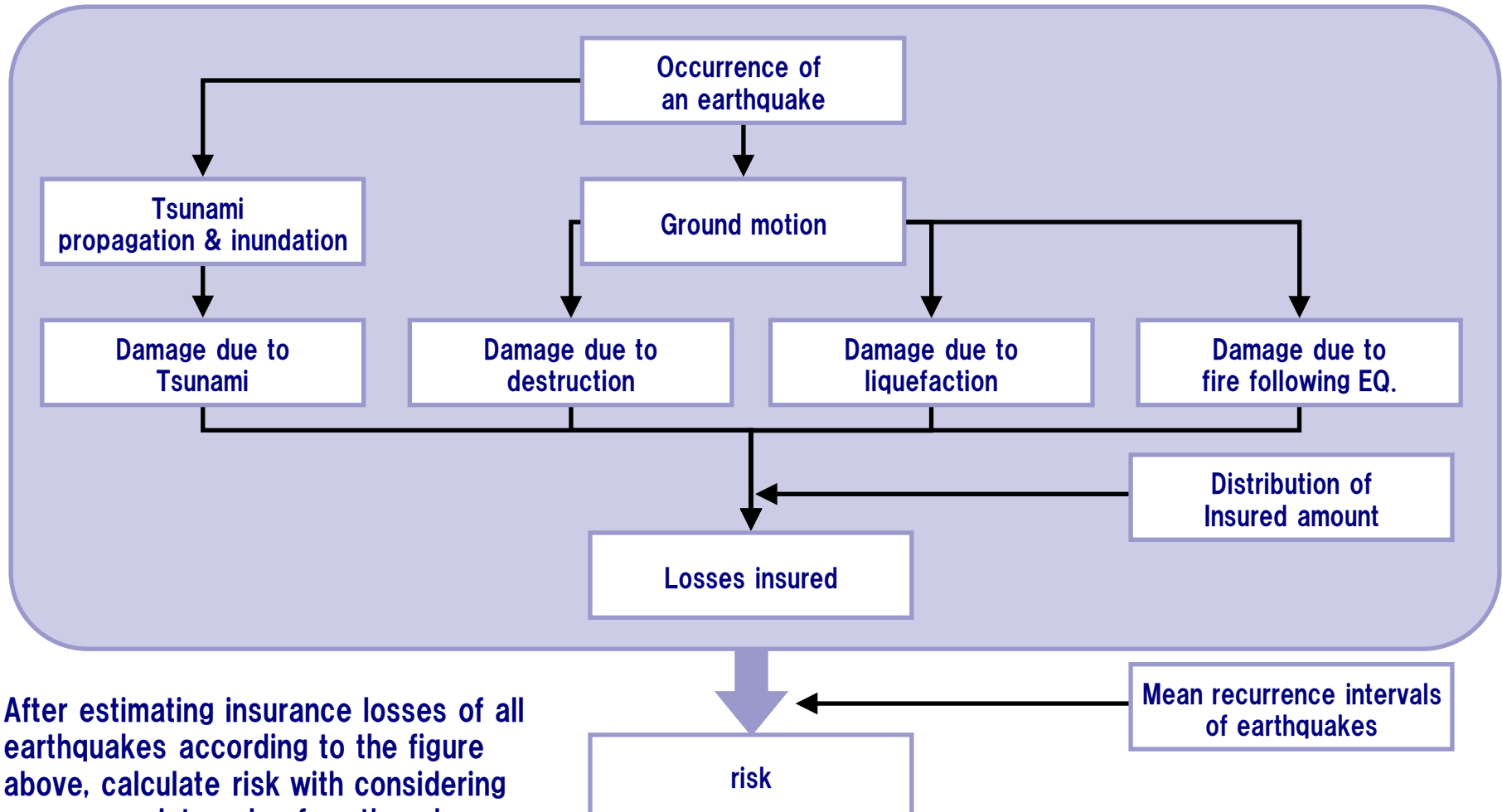Risk module is based on various researches, some of them are contract researches.

"HERP's Hazard map"

This map shows the event probability of ground motions equal to or larger than JMA seismic intensity 6 Lower, occurring within the next 30 years from the present.
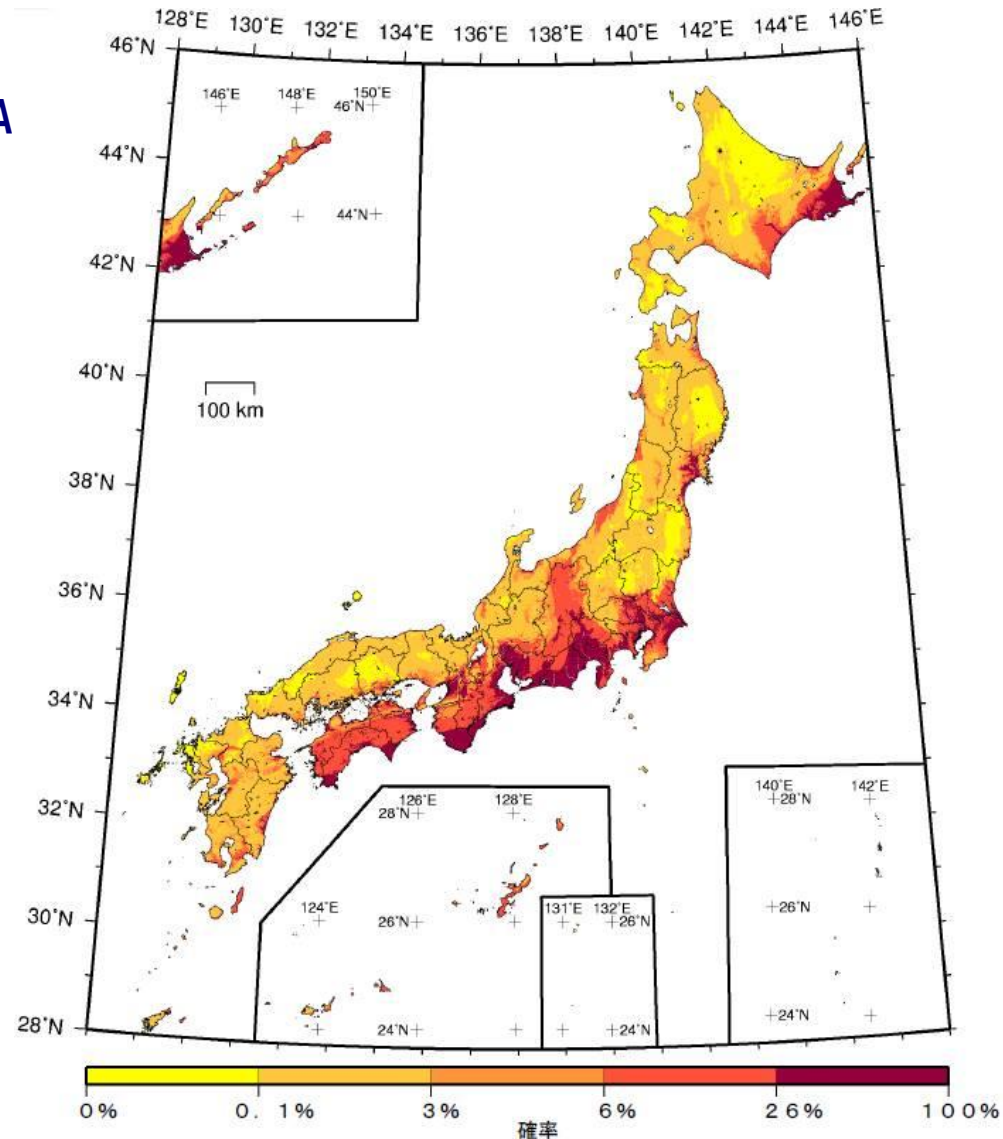
Overview of Our Earthquake Risk Model

■ **Process of our earthquake risk model**


```
                           ┌─────────────────┐
                           │  Occurrence of  │
                           │  an earthquake  │
                           └─────────────────┘
          ┌──────────────────────┬──────┴──────┐
          ▼                      ▼
┌──────────────────┐    ┌─────────────────┐
│     Tsunami      │    │  Ground motion  │──────┬──────────┐
│ propagation &    │    └─────────────────┘      │          │
│   inundation     │         │                   │          │
└──────────────────┘         ▼                   ▼          ▼
     │             ┌──────────────┐  ┌──────────────┐  ┌──────────────┐
     ▼             │ Damage due to│  │ Damage due to│  │ Damage due to│
┌──────────────┐   │  destruction │  │ liquefaction │  │ fire         │
│ Damage due to│   └──────────────┘  └──────────────┘  │ following EQ.│
│   Tsunami    │                                        └──────────────┘
└──────────────┘
                      ┌───────────────────┐
                      │   Distribution of │
                      │   Insured amount  │
                      └───────────────────┘
                      ┌──────────────┐
                      │Losses insured│
                      └──────────────┘
                      ┌───────────────────────┐
                      │ Mean recurrence        │
                      │ intervals of           │
                      │ earthquakes            │
                      └───────────────────────┘
                      ┌──────────────┐
                      │     risk     │
                      └──────────────┘
```

After estimating insurance losses of all earthquakes according to the figure above, calculate risk with considering recurrence intervals of earthquakes.
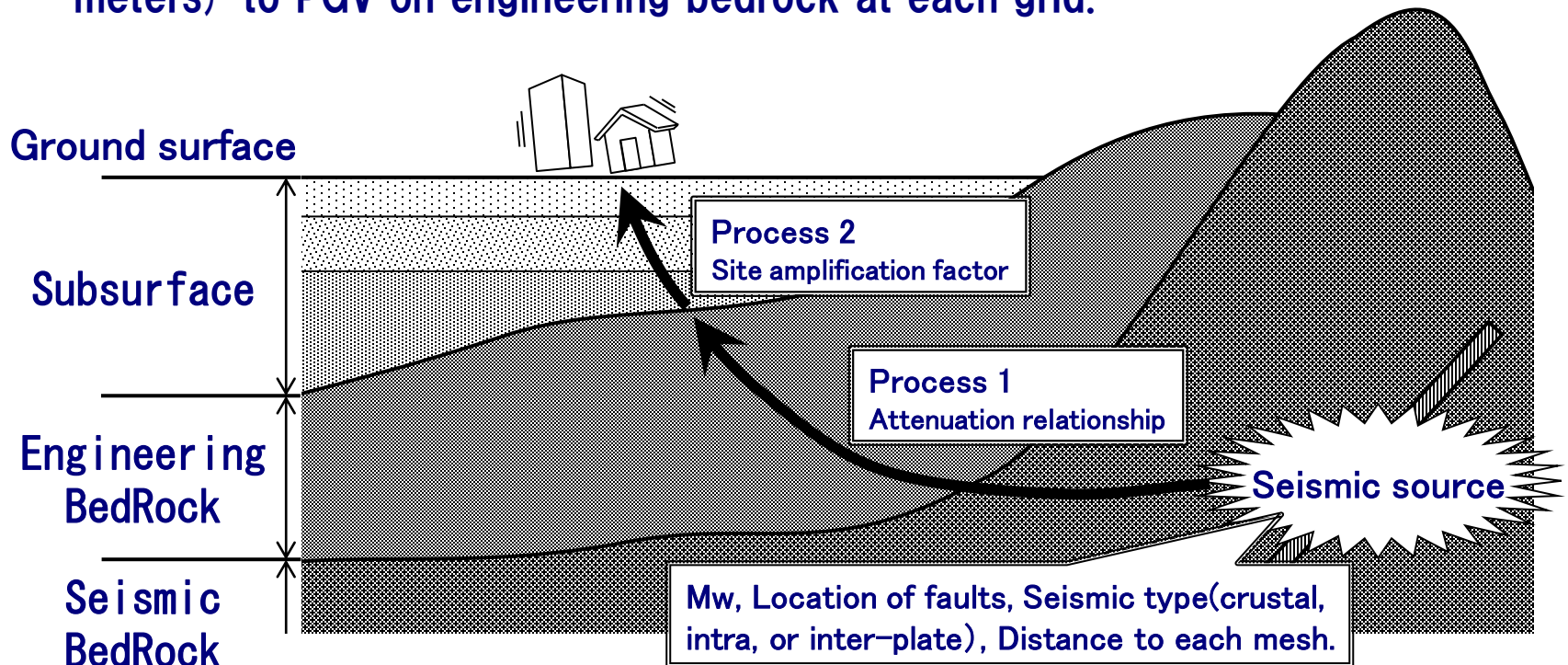
Based on HERP's Seismic Source Models

■ **Seismic sources used in the "HERP's Hazard Map" are considered in our earthquake risk model.**

ex. Active-fault earthquakes

Source: HERP
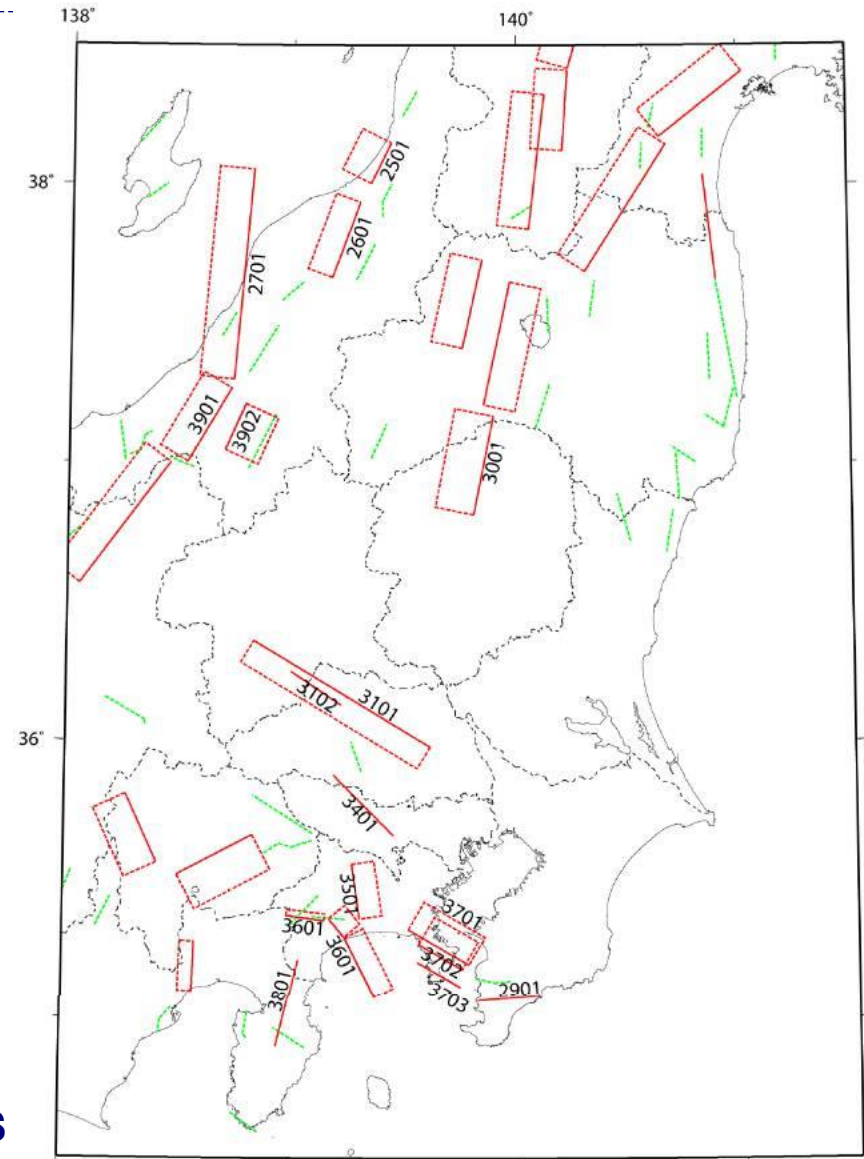
Estimate Ground Motion

- Process 1; Estimate PGV (Peak Ground Velocity) on engineering bedrock at each grid in regular grids (about 250m square) using attenuation relationships.

- Process 2; Estimate PGV on ground applying site amplification factors estimated by AVS30 (the average shear wave velocity of the upper 30 meters) to PGV on engineering bedrock at each grid.
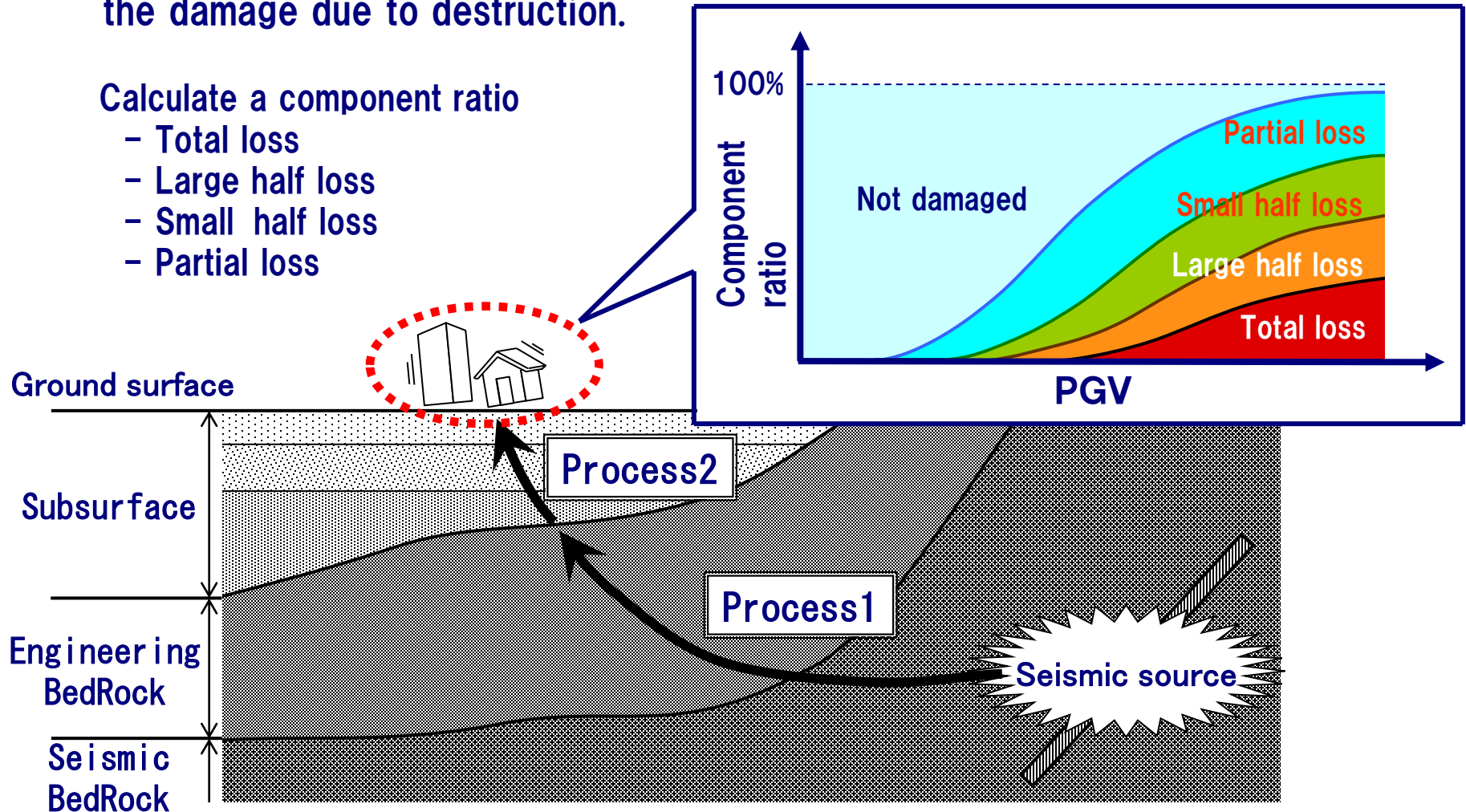
Ground surface

Subsurface

Engineering BedRock

Seismic BedRock

Process 2
Site amplification factor

Process 1
Attenuation relationship

Seismic source

Mw, Location of faults, Seismic type(crustal, intra, or inter-plate), Distance to each mesh.

Estimate Damage due to Destruction

■ **Fragility curves, in which parameters are based on PGV, are used to estimate the damage due to destruction.**

Calculate a component ratio
- Total loss
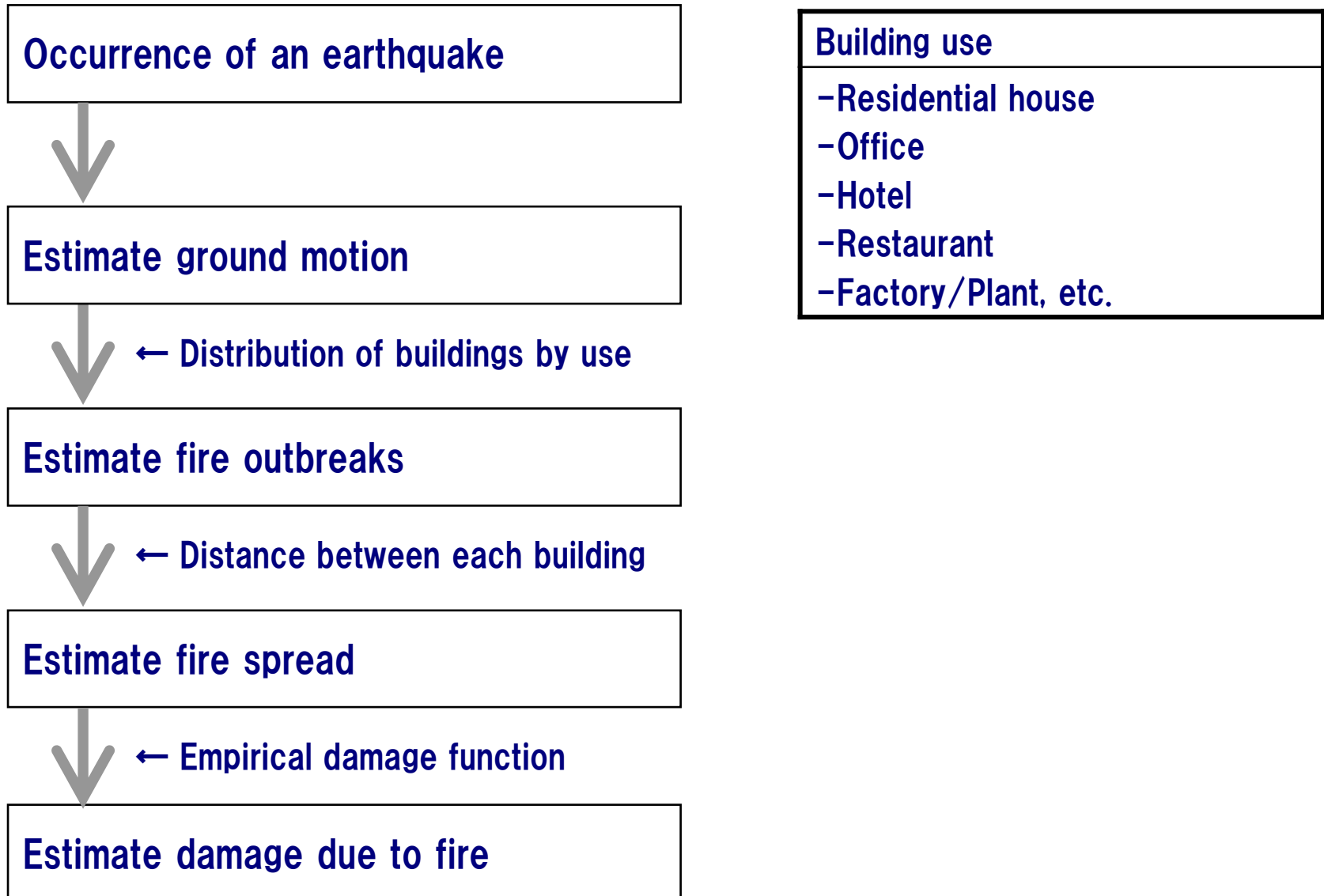- Large half loss
- Small half loss
- Partial loss

100%

Component ratio

Not damaged

Partial loss

Small half loss

Large half loss

Total loss

PGV

Ground surface

Process2

Subsurface

Process1

Engineering BedRock

Seismic source

Seismic BedRock

18 Categories for fragility curves, classified by "Structure", "Storey" and "Construction Age"
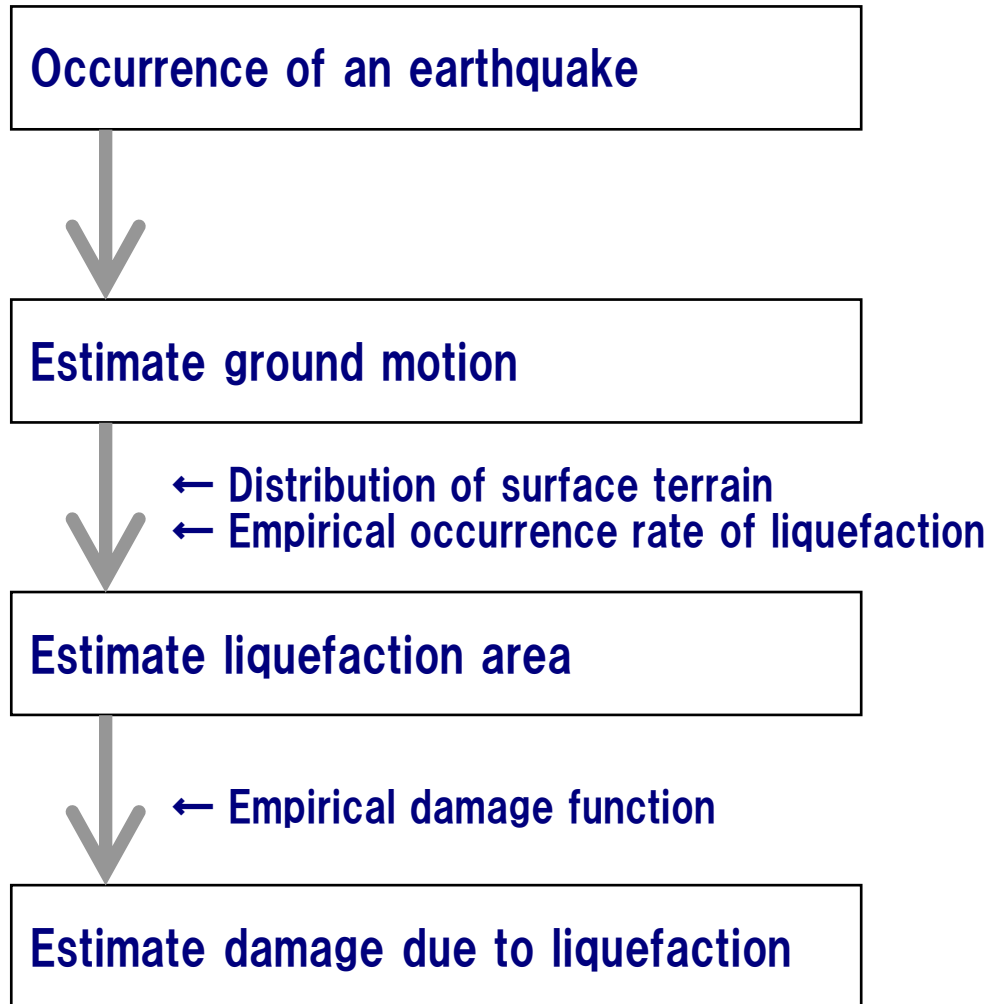
■ **Categories for buildings are below.**

Structure, Storey / Age	Wooden		Non-wooden			
	Wood frame	2x4, etc	Steel frame	RC and SRC		
				1-2F	3-5F	6F-
pre 1970						
1971 – 1980						
1981 – 2000						
post 2001						

Estimate Damage due to Fire Following Earthquakes

Occurrence of an earthquake

↓

Estimate ground motion

↓ ← Distribution of buildings by use

Estimate fire outbreaks

↓ ← Distance between each building

Estimate fire spread

↓ ← Empirical damage function

Estimate damage due to fire

Building use
−Residential house
−Office
−Hotel
−Restaurant
−Factory/Plant, etc.

Estimate Damage due to Liquefaction

Occurrence of an earthquake

↓

Estimate ground motion

↓

← **Distribution of surface terrain**
← **Empirical occurrence rate of liquefaction**

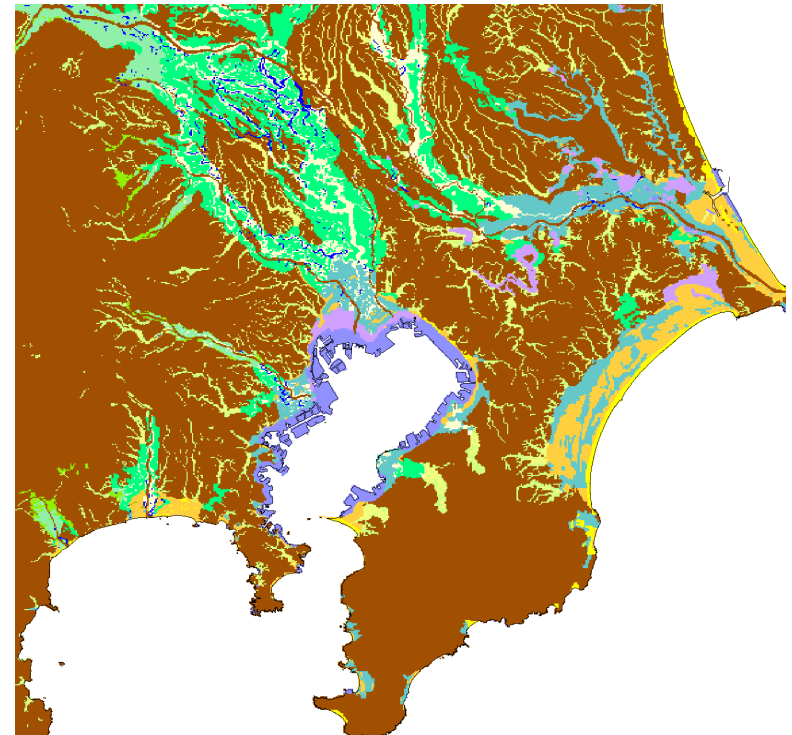**Estimate liquefaction area**

↓

← **Empirical damage function**
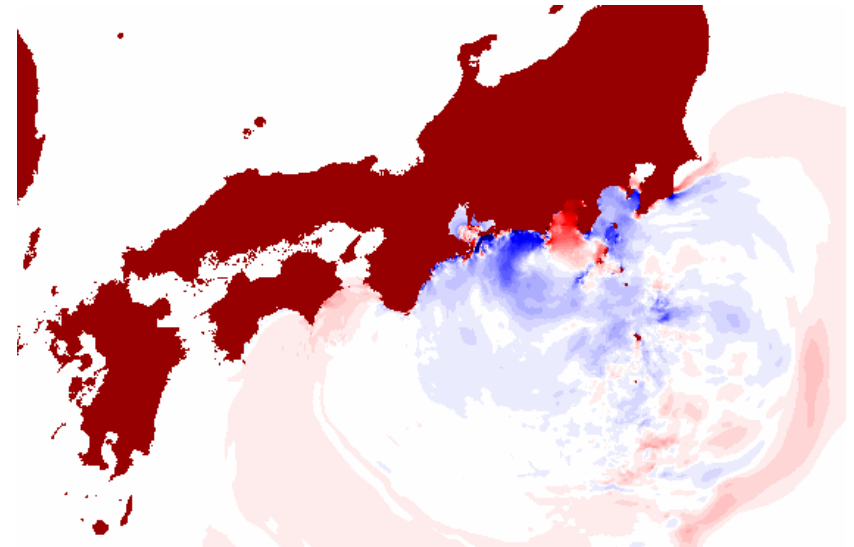
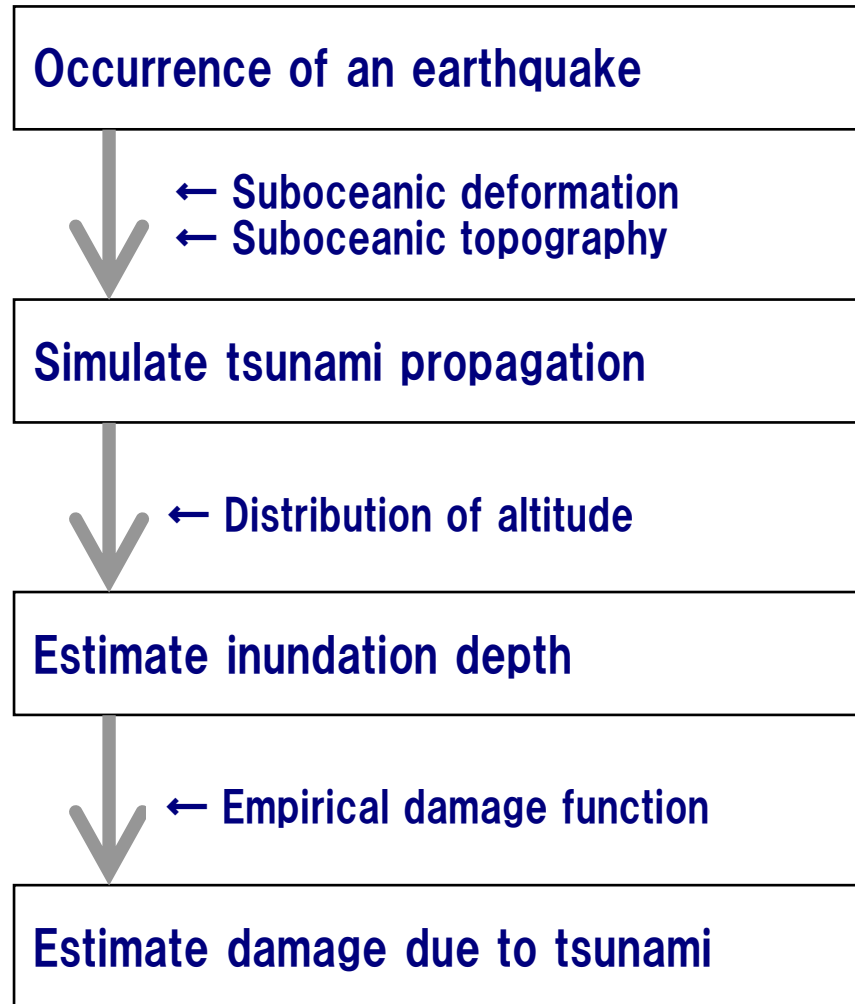**Estimate damage due to liquefaction**

- Mountain, Hill, Plateau
- Filled land
- Natural levee
- Abandoned river channels
- Marine sand and gravel bar
- Back marsh
- Delta and coastal lowland
- Reclaimed land   etc.

Nationwide surface terrain classification

Estimate Damage due to Tsunami

Occurrence of an earthquake

← Suboceanic deformation
← Suboceanic topography

Simulate tsunami propagation

← Distribution of altitude

Estimate inundation depth

← Empirical damage function

Estimate damage due to tsunami

Simulation image of tsunami caused by Tokai earthquake