An Outline of the History and Activities of the Disaster Prevention Research Institute

1. Historical Sketch

The Disaster Prevention Research Institute was founded in March, 1951, affiliated with Kyoto University, Kyoto, Japan, in order to carry out scientific research on various problems concerning the prevention of natural disasters.

The Institute commenced its work at laboratories on the University campus and at Abuyama Seismological Observatory. The following is a list of its research sections and attached laboratories with the dates of their foundation:

March 31, 1951:	Earthquake Motions Research Section,
	River Disaster Prevention Research Section,
	Earthquake Resistant Structures Research Section
August 1, 1953:	Ujigawa Hydraulic Laboratory
April 1, 1958:	Crustal Movement Research Section
April 1, 1959:	Landslides Research Section
April 1, 1960:	Applied Hydrology Research Section
December 26, 1960:	Sakurajima Volcanological Observatory
March 25, 1961:	Shirahama Oceanographic Observatory
April 1, 1961:	Wind Resistant Structures Research Section,
	Coastal Disaster Prevention Research Section
March 31, 1962:	Shionomisaki Wind Effect Laboratory
April 1, 1962:	Soil Mechanics Research Section,
	Subsidence and Failure of Soft Ground Research Section
April 1, 1963:	Applied Geomorphology Research Section,
	Drainage Engineering Research Section
April 1, 1964:	Anti-Seismic Ground-Structure Systems Research Section,
	Tottori Microearthquake Observatory
April 1, 1965:	Sedimentation and Debris Control Research Section,
	Instrumentation for Earthquake Prediction Research Section,
	Kamitakara Crustal Movement Observatory
November 23, 1965:	Hodaka Sedimentation Observatory
April 1, 1966:	Applied Climatory Research Section
November 24, 1966:	Ogata Wave Observatory

2. General View (as of January 1, 1967)

Director: Prof. Tojiro Ishihara, Eng. Dr.

Location of the Administration Office: Kyoto University Campus, Sakyoku, Kyoto, Japan

Number of staff: 234

Number of research sections: 15
Number of attached research laboratories: 8
Square measures
Land: 238, 182 m²
Architecture: 8,624 m²
Annual Revenue: ¥233,488,070

3. Research Activities

The Disaster Prevention Research Institute performs its research activities under fifteen research sections with eight attached research laboratories. These are briefly outlined in the following:

(a) Research Sections

Earthquake Motions (Head: Prof. S. Yoshikawa)

This section was founded in 1951 for the scientific and technological study on the basic problems of natural disasters, and later gained the present name. The fundamental theory respecting seismic waves and its applications are being studied in order to elucidate some problems connected with earthquake damage, especially that related to the earth ground. The substance of these studies can roughly be classified as follows:

(1) The generation and propagation of seismic waves

The origin mechanism of the natural earthquake, the vibrational characteristics of seismic waves artificially exerted and the propagation of the seismic wave in stratified media of the crust are being investigated.

(2) The relation between the earthquake motion and the ground structure

The vibrational characteristics of soft ground such as alluvium and reclaimed land and the vibrational trouble caused by artificial origins are being investigated from the viewpoint of applied seismology.

(3) The applied seismological study on the earthquake damage to ground foundations

The foundation of structures are surveyed by means of seismic explorations specially designed for engineering purposes and the relation between the method of the construction and the geological structure defined by the above method are investigated.

(4) The study on the micro-earthquake

Micro-earthquakes are observed in the Kinki district, and the seismicity in the area is being systematically investigated. The relation between the seismicity of micro-earthquakes and that of destructive earthquakes are being studied inclusively.

Crustal Movement (Head: Prof. Y. Kishimoto)

This section was founded in 1958, originally as part of a large research project concerning the crustal movements related to earthquake-occurrence. At present,

the research activities in this section include not only work on crustal movement but also a variety of other work mainly in seismology. The two main purposes of investigation in this section are, on the one hand, to throw light on the nature of earthquakes and on the other to predict earthquake-occurrence. The research items are as follows:

(1) The investigation of crustal movement

Observations by tiltmeters and extensometers have been made at about 15 observation sites. The purpose of investigation in this field is to observe the tilting motion and strain of the ground caused by the accumulation of strain energy in the focal domain of large earthquakes, and also to detect the relation between the mode of crustal deformation and earthquake-occurrence.

(2) The investigation of microearthquakes

Observation of microearthquakes (magnitude less than 3) is being carried on at the network of the Tottori Microearthquake Observatory with the use of highly sensitive seismographs. Statistical study of microearthquakes is undertaken in order to make clear the nature of the problem of earthquake-occurrence as well as the relation between the generations of minor and larger earthquakes.

(3) The investigation of earthquake mechanism

This investigation is, in a sense, the synthesis of all the research projects in this section. The processes of accumulation and release of earthquake energy are investigated from various aspects, such as crustal movements, the seismicity of microearthquakes, and the wave-form analysis of seismic long period waves observed by long period seismographs.

(4) The investigation into the predictability of earthquake-occurrence

This is one of the two main research projects in the section. Observations and investigations of crustal movements and microearthquakes are being intensified for this purpose.

Instrumentation for Earthquake Prediction (Head: Prof. M. Takada)

This section was founded in 1965, and the following subjects have been studied geophysically, in order to predict the occurrence of destructive earthquakes:

(1) The study on the forerunning phenomena of earthquakes

As earthquakes result from stresses which accumulate within the outer shell of the earth, so certain phenomena relating to the occurrence of earthquakes are expected to be observable on the surface near the epicenters. Observations for detection of these phenomena have been carried out at several points in Japan. An experimental study is now planned to investigate tectonic deformation and its relation to earthquake phenomena.

(2) The development of instruments

Instruments for observation of the forerunning phenomena of earthquake occurrences are being developed, especially with respect to telemetrical and remote-controlled operations, for high-speed data processing.

(3) The observation of seismic waves

Earthquake mechanism and crustal structure are being investigated from observational results with the use of long period and strain seismographs.

(4) The continuous observations of crustal movements

They have been carried out at Donzurubo, Iwakura, Wakayama and Amagase, in cooperation with Crustal Movement Research Section. In addition, ground movements in the fractured zone and on the landslide site are also being investigated.

Earthquake Resistant Structures (Head: Prof. M. Wakabayashi)

This section was founded in 1951 for the synthetic study on the prevention of earthquake and wind disasters, and later gained its present name. In order to find a reasonable design method for earthquake resistant structures, some fundamental problems are being investigated on the strength and deformation of structures. They include:

(1) The restoring-force characteristics of tall frames

Research here is to clarify the behavior of frames under the combined action of vertical constant loads and horizontal varying forces. Attention is paid, in particular, to the inelastic range of structural behavior.

(2) The inelastic behavior of frames under repeated loading

Experimental studies are being performed whose main emphasis is on the effect of the bracings and the energy absorption characteristics of rigid frames.

(3) The permanent deformation of structures due to large impact loads

Experiments are now being carried out to ascertain the plastic behavior of ductile frames under impulsive loading.

(4) The buckling strength of steel structures

Included are rigid-frames and structural members.

(5) Some basic problems in the experimental investigation of complex structures

This is the preparatory step toward the experimental stress analysis of shells.

(6) Some chemical studies on fire disasters

Experimental studies are also being made on fire-extinguishing techniques.

Anti-Seismic Ground-Structure Systems (Head: Prof. R. Minai)

This research section was established in April, 1964 in order to study the relationship between the earthquake damage sustained by strcutures and the dynamic characteristics of ground soil and to find a reasonable method of preventing the earthquake damage to the ground-structure system. The following is an outline of the research activities of this section:

(1) The earthquake excitation patterns which are consistent with the dynamic characteristics of the ground and the seismicity of the site of construction have mainly been studied by the statistical method.

(2) The dynamic model of the coupled ground-structure system and the measures of anti-seismic precaution of this system have been studied by both the theoretical and the experimental methods.

(3) The methods of earthquake response analyses of ground-structure systems subjected to deterministic or stochastic non-stationary excitiations have been studied. The properties of the earthquake responses of the coupled system have been clarified through the numerical approach.

(4) The anti-seismic design method of ground-structure systems has been studied. The statistical anti-seismic design method for moderately intense earthquake excitations and the ultimate anti-seismic design method for very intense earthquake excitations have been developed.

(5) Some experimental studies on the dynamic characteristics and earthquake responses of the actual coupled ground-structure systems have been continued.

Applied Hydrology (Head: Prof. Y. Ishihara)

Extensive research has been carried on in order to elucidate the hydrological phenomena with respect to disaster caused primarily by storm rainfall and to establish engineering techniques for disaster prevention. The following specific fields are covered:

(1) The characteristics of rainfall in relation to runoff

(2) The runoff phenomena on the surface of a river-basin and the flood flow through a stream channel

(3) The hydrologic behavior of ground-water and its runoff into streams

(4) The runoff analysis and the flood prediction

(5) The flood control

(6) The water balance

(7) The statistical analysis of hydrological data and its engineering application

As one of the projects of the International Hydrological Decade proposed by UNESCO, a variety of field observations, such as the experimental basin and plot now under construction in the drainage area of Lake Biwa, for examining the runoff process and the water balance, are being conducted. This work is being performed with the the cooperation of research members belonging to the other Research Sections and the Faculties of Science, Engineering and Agriculture.

Sedimentation and Debris Control (Head: Prof. K. Yano)

Basic and applied research has been carried out to ascertain the mechanism of the sediment yield in a mountain basin together with its transportation and to establish a method for preventing flood disasters caused by anomalous sediment yields. With regard to field investigations, basic observations on run-off characteristics in a high altitude mountain basin, the sediment yield and transportation, and characteristics of mud flows are being conducted at the Hodaka Sedimentation Observatory established in 1965. The Main subjects now being studied are as follows:

(1) The sediment yields and the run-off in a mountain basin

(2) The mechanics of the sediment transport in a stream

(3) The hydraulics of the mud flow

(4) The local scour downstream of hydraulic structures
(5) The hydraulic design of debris control structures

River Disaster Prevention (Head: Prof. K. Ashida)

This section was founded in 1951 for the synthetic study of water disaster prevention, and later gained the present name. In order to establish the engineering basis for disaster prevention and the utilization of water in rivers, fundamental laboratory studies and field investigations have been carried out in this section. The main subjects being studied are as follows:

(1) Some basic studies on sedimentation in reservoirs and river stabilization
(2) The behavior of unsteady flow in an open channel under various boundary conditions
(3) The stochastic analysis of bed forms and the resistance law in open channel
(4) The flow structure of curved open channels
(5) Basic studies on river meandering and local scouring at bends
(6) Field observation of river floods and sedimentation

Drainage Engineering (Head: Prof. M. Kadoya)

In this section, fundamental research and some field investigations have been carried on in order to ascertain the mechanism of floods in low-lying areas and to elucidate problems of drainage engineering. The chief data respecting present research activities are as follows:

(1) The runoff characteristics in the basin were conditioned by a small mountain, hill, urban land and agricultural land.
(2) The mechanism of the flood in low-lying land and the establishment of the drainage method.
(3) The hydraulic problems of the drainage system: for example, the resistance law of the flow where there is a very mild hydraulic gradient, the sediment hydraulics in the drainage channel, the flow characteristics of the drainage culvert, and so on.
(4) The behavior of the ground water and its control.
(5) The economical planning of water-works.

Coastal Disaster Prevention (Head: Prof. Y. Iwagaki)

Fundamental studies on coastal engineering have been carried out at the Ujigawa Hydraulic Laboratory in order to solve various hydraulic problems in shallow water. In addition, field investigations to prevent coastal disasters due to wave action have been carried out at several coastal points in Japan. The main subjects of study are as follows:

(1) Some basic studies on the wave damping due to bottom friction.
(2) The field observations and characteristics of shallow water wave spectra.
(3) The overtopping and run-up of waves against shore structures.
(4) The air-sea boundary process.

(5) The beach processes and sediment transport by waves and currents.
(6) The resonance effect in storm surges.

Subsidence and Failure of Soft Ground (Head: Prof. S. Murayama)

In this section, as a fundamental research project, the mechanical properties of soil as well as soft rock are studied. Among these, the present subjects are the creep and stress relaxation of clay, the effect of the intermediate principal stress on the deformation and strength of soils, the effect of the structure of clay particles on its mechanical behavior, the dilatancy of soils and the expansion of soft rock due to the sucking of water, etc..

As extensive problems, the following subjects are investigated theoretically and experimentally:

(1) The land subsidence
(2) The bearing capacity
(3) The ground pressure on undergound structures

Beside these static problems, the mechanical behavior of soil in a dynamic state is investigated to improve the asysmic analysis of the foundation.

Applied Geomorphology (Head: Prof. S. Okuda)

This section was established in 1963 for the synthetic research of the exogenetic processes controlling the surface features of the Earth and the fundamental development of preventive methods against various disasters resulting from these processes. In this section, active studies for the progress of physical geomorphology and its effective application to disaster prevention are being carried out with respect to the following problems:

(1) The weathering of bed rock and wasting of slope

Field surveys of water balance and the geochemical analysis of streams and springs in mountain regions are being carried out in order to study the hydrological conditions which stimulate weathering and to prevent the disasters due to the wasting of slopes.

(2) The thermal soil physics

Geocryogenical studies on the deformation of frozen soil and moisture movement in freezing soil are being carried out in order to prevent soil fracture and frost heaving. Some other thermal effects on soil structure and moisture are being studied, also, with the reference to solifluction and surface freezing.

(3) The applied sedimentology

New instruments for measuring the deposition rate, turbidity, water temperature, conductivity and water depth have been devised and set in the lakes or reservoirs to pursuit study of the relation between hydrological conditions and sedimentation. Flume experiments, hydrochemical surveys and air-photograph interpretation are being carried out for the geomorphological study of river meandering and delta development, and for the planning of reservoirs.

Landslides (Head: Prof. S. Yamaguchi)

There are many landslides in Japan amounting to 6,000 per annum. They include various types, for example, tertiary type, fractured zone type, volcanic or hotspring type, etc. Therefore, the study of landslides arouses a great deal of interest. On the other hand, the rapid progress of civil construction during this century, under the impact of advancing civilization, which has seen the realization of such large construction works as dams, railways, highways, etc., has been the cause of serious damage. Particularly endangered those people who live in districts close to mountains.

As urgently requested, we are improving the methods of landslide investigation and taking into account economic, political and human factors.

This section has been established for the purpose of studying landslides, but disasters that occur on slopes also come into our field of study. In order to achieve these objects we are engaged in the following projects:

(1) The study of the soil in landslide areas

(2) The study of the stereographic mechanism of occurrences and the creeping process in landslides

(3) The study of the forecasting of landslides

(4) The study of techniques of prevention and control of landslides

(5) The geological and geographical study of landslides

(6) The study of the relationship between basic factors and the inducement of landslides throughout the world.

One of our observatories is in Tokushima Prefecture, where there are plenty of landslides, so that we can test our theories by relating them to actual landslide occurrences.

Wind Resistant Structures (Head: Prof. H. Ishizaki)

This section began its research in 1961 and the research projects completed prior to 1966 or in progress now are as follows:

(1) Some studies on the maximum wind speed distribution in the typhoon and their topographic modifications.

(2) The theoretical and experimental research on the characteristics of anemometers, especially on their response to gusty winds. As a result of this study some new type anemometers such as the quick response pressure tube anemometer have been completed.

(3) Some observational studies on the spatial structures of storm gusts with the use of a quick response anemometer network.

(4) Some comparative studies on the actual wind pressure distributions on a house with results of model experiments in the wind tunnel, especially on the problem of negative wind pressure fluctuations on the roof or wall.

(5) The survey of the distribution of wooden houses destroyed by wind for each

of the recent severe typhoons, with special attention to the damage rate in relation to maximum wind speeds.

(6) The theoretical and experimental research on the vibrations of houses, steel towers, large stacks or other structures caused by winds. The experiments are being carried out both in the wind tunnel with models and in the experimental field with actual structures.

Applied Climatology (Head: Prof. C. Nakajima)

In this section, the relation between local climate and local disaster features is studied. Fundamental research on long-range weather forecasting for disaster prevention has also been conducted. The main subjects are as follows:

(1) The effect of the topography on the local climate.
(2) The experimental study of local climate.
(3) The study of heavy rains for flood forecasting.
(4) The forecasting and prevention of fogs.
(5) The transport and diffusion of sea-salt particles in the atmosphere.
(6) The long-range weather forecasting.

(b) Attached Laboratories

Ujigawa Hydraulic Laboratory (Director: Prof. S. Murayama)

In this laboratory the experimental studies, together with the field observations, have been conducted to elucidate the mechanism of the river and coastal current, by use of various apparatus and the method of measurement which has been developed here. Three research projects have been carried out in this laboratory. The first project is to reveal the behavior of open channel flow contributing to the hydraulic design of the river structures and to develop more rational design procedures. The main contents of present research are as follows:

(1) The behavior of varied flow in an open channel with bottom diversion racks.

(2) The applicability of the theory of the gradually varied flow of nonuniform discharge to design procedures of the diversion works which satisfy the discharge requirements.

(3) The hydraulic performance of the stilling basin appurtenances and the mechanism of a hydraulic jump.

The second project is to reveal the turbulence structure of the river flow, which consists of the following items:

(1) The properties of the spectra of large scale turbulence over the river width which are observed by the use of a propeller type of current meter.

(2) The measurement of fine structures of a boundary layer turbulence, such as the flow near the water surface and the corner region, by the use of the ultrasonic flowmeter with two components.

(3) The turbulence spectra of the bottom shear stresses of the open channel

flow which are obtained by the use of the direct balance type and hot film type shear meter

The third project is tidal observation to reveal local characteristics of the tide near the coast and the effect of tidal currents on the other physical factors, which will yield important and fundamental data for theoretical and experimental studies and for the planning of disaster prevention in coastal regions.

(1) Studies on storm surges, tsunami and tides near the coast and river mouth have been continued theoretically and experimentally with successful results.

(2) A hydraulic model experiment on the behavior of storm surges in river and canal has been carried out to prove the effect of the storm surge gates on the piling-up of water by a storm surge.

Sakurajima Volcanological Observatory (Director: Prof. (Assist.) K. Yoshikawa)

This observatory was established in 1962, for the purpose of undertaking fundamental research on the mechanism of volcanic eruptions, and on predictions for the explosion of Sakurajima volcano which is the most active in Japan.

In this observatory, the following routine observations and temporary surveys have been carried out in order to obtain fundamental data for the various volcanic phenomena.

(1) Volcanic earthquakes are observed by high sensitivity and other seismograms in multipartite stations to investigate the nature of them.

(2) Shock waves caused by volcanic explosions are observed by Shida-type and electro-magnetic type microbarographs to estimate the magnitude of the explosion.

(3) Volcanic crustal deformations are observed by tiltmeters, extensometers and tidegauges set in many places in order to investigate the relation between ground deformations and volcanic activity.

(4) Precise levellings are repeated over brief periods to find the vertical crustal deformation associated with the volcanic activity.

(5) Graviemtric and geomagnetic surveys are carried out over brief periods to investigate the crustal structure and the change of physical nature of the magma reservoir with time.

(6) Underground temperature is measured to examine its relation to the volcanic activity.

(7) Meteorological observations are being continued in order to examine the meteorological conditions relating to volcanic phenomena.

Tottori Microearthquake Observatory (Director: Prof. Y. Kishimoto)

Tottori Microearthquake Observatory planned by the "Earthquake Prediction Research Group in Japan", was established in 1964, as one of a network of observatories covering the whole of Japan for the observation of microearthquakes. At present, this observatory has 11 sub-stations mainly in the northern part of Kinki District, namely Funaoka (Tottori Pref.), Mikazuki, Oya, Izumi and Hikami (Hyogo

Pref.), Takatsuki and Myoken (Osaka Pref.), Yagi, Kyohoku and Kamigamo (Kyoto Pref.) and Iwaoyama (Shiga Pref.). These stations are equipped with very highly sensitive seismographs, and continuous observation is carried on with a high degree of sensitivity and of accuracy in time keeping.

The main research project is to discover the nature of microearthquakes directly related to the occurrence of large earthquakes. Up to the present time, the distribution of earthquake foci, the distribution of earthquake magnitude, the variation of seismicity with time and region, the mechanism of microearthquakes as well as large earthquakes, and other problems have been investigated in the area concerned for the purpose mentioned above. In the future, the construction of new sub-stations is expected especially in the epicentral area of the destructive Tottori earthquake, and also observations of ultra-microearthquakes are planned through car-borne moving stations equipped with an ultra-sensitive seismograph system.

Kamitakara Crustal Movement Observatory (Director: Prof. T. Ichinohe)

The Kamitakara Crustal Movement Observatory was established on April 1st, 1965, for the purpose of investigating the relations between crustal movement and earthquake occurrence and finding some clues for earthquake prediction. The observatory consists of the three parts of the main building, an observation dome and an observation tunnel, the locations of which are as follows:

Observation dome: $\lambda=137°21'57''$E, $\varphi=36°17'20''$N, h=600 m,

Observation tunnel: $\lambda=137°19'42''$E, $\varphi=36°16'54''$N, h=800 m.

The main subjects of observations and investigations being carried out in this observatory are as follows:

(1) The measurements of crustal movements by means of geodetic methods.

(2) The continuous observations of crustal movements by means of extensometers, tiltometers and the like.

(3) The routine observations of seismic activities by means of various seismographs.

(4) The adjustment and analysis of the observational data on crustal movements.

(5) The synthetic investigation of the methods for earthquake prediction.

Shirahama Oceanographic Observatory (Director: Prof. Y. Iwagaki)

The purpose of this observatory is to make organic observations of the whole air-sea system by using the tower station constructed as a branch facility of this observatory. The characteristics of the sea under high speed wind, especially wind waves and storm surges caused by a typhoon, structures of wind above the sea surface and wind driven currents, tsunamis caused by an earthquake or a volcanic erruption, etc., have been investigated.

The tower stands on a submerged rock where the mean water depth is 5.5 m, and the top of the tower is as high as 12.7 m above the mean sea level. Physical,

chemical and biological quantities to be measured are as follows:
Atmospheric pressure, precipitation, radiation, air temperature, humidity, wind direction, wind speed, water temperature, salinity, turbidity, current direction and velocity, tide, wave, and plankton.

Continuous records of these quantities are being taken by batteries charged twice a month.

Shionomisaki Wind Effect Laboratory (Director: Prof. H. Ishizaki)

The laboratory was opened in 1961 at Shionomisaki, Wakayama Prefecture in cooperation with the wind disaster section. It is located on a site of about 4000 m^2 near the south coast of central Japan and this area is attacked by typhoons every year so often that it is an appropriate place for making experiments with strong wind. The observations or measurements now in progress are as follows:

(1) Some comparative studies on the responses of various anemometers in a natural wind.

(2) The observation on the structure of wind turbulence with the use of quick response anemometers and sonic anemometers.

(3) The observation on the wind shear near the ground by various anemometers.

(4) The measurement of the wind pressure distribution on actual structures, such as steel towers and houses, especially on pressure fluctuations.

(5) The measurement of the vibrations of some structures induced by wind.

Hodaka Sedimentation Observatory (Director: Prof. K. Yano)

This observatory was established in 1965 in order to perform organic observations of run-off and sediment yield during floods in the Gamata River basin, which is located in the North Japan Alps at an altitude of approximately 1,000 m to 3,000 m. This observatory is composed of an observation house, covering 68 m^2 in area, a soil festing house, covering 40 m^2 in area, and the Hiru-dani Experimental Watershed, located at 1,200 m to 2,400 m above sea level, the basin area being 0.85 km^2. In the Hiru-dani Experimental Watershed there are six rain-gauge stations for observing the characteristics of rainfall and one dam for observing the flood discharge and the rate of sediment yield. Additional facilities for observing the mud flow and the characteristics of snow and its run-off are to be established in the near future.

Ogata Wave Observatory (Director: Prof. Y. Iwagaki)

This observatory which was opened in November, 1966, is located at the Ogata Coast, Niigata Prefecture, facing the Japan Sea. Near the observatory, there is a pier, 314 m long, 3.3 m wide and 15 m high above the mean sea level off this coast, and a tower, which is located 1.5 km off the coast, constructed by Teikoku-Sekiyu Oil Co. Ltd..

The purpose of this observatory is to observe the transformation of coastal waves

in shallow water, longshore currents, sand drift and the variation of beach profiles, etc., by using the facilities and equipments installed in the pier and in the tower.

At present, continuous records of shoaling waves are being measured by one and six step-resistance type wave meters installed in the tower and the pier respectively. In addition, the following meteorological data are being recorded:

(1) The wind speed, (2) The wind direction, and (3) The atmospheric pressure