

# Emergent Survey on the Disasters by the 2019 Boso Peninsula Typhoon, East Japan Typhoon, etc.

Emergency Survey Team consisting of National Institute for Land and Infrastructure Management, Public Works Research Institute, Building Research Institute, and Port and Airport Research Institute of National Institute of Maritime, Port and Aviation Technology

*key words: disaster emergency survey, typhoon damage*

## 1. Introduction

Immediately after the occurrence of disasters by the 2019 Boso Peninsula Typhoon, East Japan Typhoon, etc., National Institute for Land and Infrastructure Management ("NILIM"), Public Works Research Institute ("PWRI"), Building Research Institute ("BRI"), and Port and Airport Research Institute ("PARI") of National Institute of Maritime, Port and Aviation Technology (National Research and Development Agency), in cooperation with each other, participated in the field activities in each site as experts and members of the Technical Emergency Control Force (TEC-FORCE) of the Ministry of Land, Infrastructure, Transport and Tourism ("MLIT") and organized a voluntary survey team and dispatched their personnel to disaster sites.

This paper reports as a quick bulletin the outline of damage, etc. caused by the 2019 Boso Peninsula Typhoon, East Japan Typhoon, etc. based on the emergency field survey by classifying the disasters by facility etc. Note that numerical values etc. reported in this paper include those as of the survey.

## 2. Damage confirmed by the emergency survey

### 2.1 Damage to sewerage facilities

Sewerage facilities suffered serious damage from the inundation and sediment disasters caused by the 2019 East Japan Typhoon, etc.

The function of sewage treatment also stopped at 16 treatment facilities, including Fukushima Abukuma River Upstream Northeast Prefecture Treatment Center and Nagano Chikuma River Downstream Treatment Facility. Of these facilities, as of the end of February 2020, 13 facilities resumed normal operation and 3 facilities are operating with simple treatment. As for pumping stations, a total of 28 facilities in 6 prefectures including Miyagi, Fukushima, and Nagano stopped operation due to inundation damage. Of these facilities, as of the end of February 2020, 19 facilities resumed normal operation, 9 facilities are taking emergency measures, and 8 facilities secured part of the drainage capacity.

Damage also occurred at a total of 100 spots in the pipeline facilities of 2 prefectures, 13 cities, 6 towns, and 1 association and 104 spots in manhole pumps in 28 cities, 13 towns, and 2 villages, in the region from Tohoku to Kanto.

### (1) Fukushima Abukuma River Upstream Northeast Prefecture Treatment Center

The Northeast Prefecture Treatment Center is a treatment facility with the treatment capacity of 87,800 m<sup>3</sup>/day, covering Fukushima-shi, Date-shi, Kunimi-cho, and Koori-machi. Due to the heavy rain by the 2019 East Japan Typhoon and subsequent failure of the levee of the Taki River, flowing through Kunimi-cho, Fukushima-ken, the whole treatment facility submerged and lost the treatment function due to equipment failure. After suffering the damage, the facility, through the operation with disinfection treatment, is considering measures for phased water quality improvement in view of a long period up to the full recovery. Note that the NILIM dispatched experts to the site on October 23, 2019 and January 10, 2020 to grasp the status of temporary measures and gave technical advice on emergency measures.

### (2) Treatment facility in the Nagano-ken Chikuma River Basin Sewage Downstream Treatment Area

Treatment facility in the Chikuma River Basin Downstream Treatment Area has the treatment capacity of 69,000 m<sup>3</sup>/day, covering the treatment area of Northern Nagano-shi, Suzaka-shi, Obuse-machi, and Takayama-mura. Located near the JR East Japan Nagano Shinkansen Rolling Stock Center, the facility on the whole submerged due to the levee failure of the Chikuma River and its function stopped (Photo 1).



**Photo 1 Disaster in the treatment facility of the Chikuma River Basin Downstream Treatment Area**  
Photo source: Nagano-ken

After suffering the disaster and subsiding of the inundation, the facility resumed acceptance of sewage from October 19 and started disinfection operation. Then, after installing a temporary pump, the facility started operation with simple treatment (precipitation + disinfection).

For the future, the facility has been preparing for restoration, including restart of simple biological treatment in turn for each system.

### (3) Damage to pipeline facilities

As for damage to pipeline facilities, in addition to the damage in wide area and increase in the number of cases, events of spill and scouring in the inundated area and elevation phenomenon, which had been rarely observed in the past events of inundation, were also outstanding and types of damage were various, so that the NILIM is organizing damage types based on the damage information from the MLIT and striving to grasp the characteristics of damage to pipelines by the heavy rain of the 2019 East Japan Typhoon.

### (4) Summary

If a sewage treatment plant suffers destructive damage due to inundation etc., it is necessary to recover the function as early as possible but recovery of electric / machine equipment will take a long time. It is therefore required to advance restoration work to improve water quality in stages, while securing the minimum treatment function of the facility.

In addition, hydraulic phenomena of pipeline facilities in the event of heavy rain, such as back run of foreland water and impact pressure of water / air, are not clarified and it is therefore difficult to take countermeasures, so that solution of the phenomena is urgently required.

## 2.2 Damage to river management facilities

The 2019 East Japan Typhoon caused wide-area damage to river management facilities, including the levee failure in Miyagi-ken, Fukushima-ken, Ibaraki-ken, Tochigi-ken, Saitama-ken, Niigata-ken, and Nagano-ken. NILIM's River Department and PWRI's Geology / Ground Research Group, Hydraulic Engineering Research Group, and Cold Region Hydrosphere Group conducted a field survey in cooperation with the MLIT, Regional Development Bureau, and prefectures including participation in the Levee Survey Committee for the purpose of investigating the causes of damage and studying restoration methods. A total of 68 persons from 19 teams engaged in the survey to investigate the damage caused by the 2019 East Japan Typhoon, the low pressure generated subsequently on October 25, and Typhoon No. 21. The following introduces part of the survey.

Note that NILIM's River Department and PWRI's Water Environment Research Group, as of March 19, 2020, following the emergency damage survey, dispatched 14 teams of advisors of Nature-oriented River Management, which aims to promote further effective / efficient promotion of nature-oriented river

development, in response to the request of the Regional Development Bureau and prefectures to support the restoration of affected areas.

### (1) Tohoku Region

In the Tohoku Region, as the first Levee Survey Committee, we conducted a survey on October 16 about the collapsed area in the direct control section at 98.6 kp on the left bank of the Abukuma River and at 20.9 kp on the left bank of the Yoshida River in the Naruse River System. In the Abukuma River, collapse occurred in the section of about 50 m, where a sluice gate is located. Redevelopment of the levee site was proceeding in the emergency restoration work at the time of the survey and there were a slope inside the levee that seems a levee slope toe and a sign board that had probably been installed at the top end / top of slope and tilted toward the river side.

In the Yoshida River, a levee failure occurred in the section of about 100 m, located on the downstream side where the levee normal line turned toward the river side (Photo 2). In the back of the river side slope at the foot of the berm where the slope pavement is installed, a pool dug where the basic ground is deeply dug was formed and its ground surface was comprised of sediment that includes fine grained soil. Note that the CCTV video depicting the flooding at this point caught the flood flowing over the crest.



**Photo 2 Collapse at 20.9 kp on the left bank of the Yoshida River in the Naruse River System (Oct. 16)**

In addition, in the individual survey conducted on October 22, collapse of the river side slope was found at 8.4 kp on the left side of the Naruse River. The slope collapsed about 30 m in length and the collapsed sediment seemed to have fallen down to the major bed. The emergency recovery work was going on when the field survey was conducted and the collapsed sediment was already removed completely by heavy equipment working on the slope. The collapsed sediment was relatively thick, about 2 m, and there was an open crack on the slope extending over 200 m in the upstream of the collapsed section.

### (2) Kanto Region

In the river levees under direct control of the Kanto Regional Development Bureau, levee failure occurred

at 3 spots in the Oppo River and Toki River, branch rivers of the Ara River, and 3 spots in the Naka River, and 3 spots in the Kuji River.

The Levee Survey Committee, organized by the Kanto Regional Development Bureau, conducted a field survey on October 17 about the 3 collapsed spots in the Ara River System and on October 18 about the 3 collapsed spots in the Naka River and Kuji River (Photo 3), respectively.

On all the sites of these 9 spots, a cofferdam was being installed in the emergency recovery work. In all the collapsed spots, trace of overtopping, far exceeding the design water level of the levee, was confirmed.



**Photo 3 Collapse at 28.6 kp on the right bank of Naka River (Oct. 18)**

### (3) Hokuriku Region

At 58 kp on the left bank of the Chikuma River, the levee collapsed about 70 m in length and an area of about 9.5 km<sup>2</sup> including Oaza Hoyasu and Oaza Akanuma, Nagano-shi, was inundated. The Levee Survey Committee, organized by the Hokuriku Regional Development Bureau, conducted a field survey on October 15 about the spots of collapse, etc. in the Chikuma River. At the spot of collapse, there remains part of the levee in which a large pool dug by flood stream was formed toward the inside of the levee, from which the violent flood flow at the time of collapse could be presumed. At 104 kp on the left bank of the Chikuma River, the levee was lost and the left bank side of the Chikuma River Bride, across the same spot, on the Besho Line of Uedadentetsu was scoured and the bridge girder fell because the abutment was washed away (Photo 4). The riverbed slope is steep, about 1/200, on the same spot and the erosion force acting on the riverbank is large in the section.

In addition, in the individual survey conducted on October 26, the spot where levee revetments were damaged and the bridge across the riversides fell was confirmed, although the measures for water colliding front, including installation of groyne, had been progressing in the area of Tomi-shi Umino site to Tanaka site, located in immediately upstream of the direct control section since it is located in the outer bank of the bend.



**Photo 4 Levee collapse at 104 kp on the left bank of the Chikuma River  
Situation of damage (Oct. 15)**

In addition, in the individual survey conducted on October 30, collapse of the land side slope was found at 57 kp on the left side of the Chikuma River. The thickness of collapsed soil was thin, about 0.5 m, which means the collapse of only the surface part. It was, however, characteristic that the collapsed soil on the whole greatly moved to the ground inside the levee. The case of large movement of collapsed soil was found at multiple spots including the case of Naruse River.

### 2.3 Sediment disaster

#### (1) Outline of sediment disaster

The heavy rain of the 2019 East Japan Typhoon caused a total of 952 sediment disasters in Tokyo and 19 prefectures and the dead and missing persons totaled 17 (The MLIT's Survey as of Dec.24). Particularly, in Miyagi-ken, 254 sediment disasters occurred (Photo 5).



**Photo 5 Frequent slope collapse and debris flow  
(Igu-gun, Miyagi)  
Mawarigura Area, Marumori-machi, Oct. 17)**

Particularly, in Marumori-machi, Igu-gun, Miyagi, debris flow and surface failure occurred almost simultaneously and the riverbed rise and channel clogging resulting from runoff of a large amount of sediment also caused damage by sediment / flood inundation. As a factor of such damage, the rainfall, totaling 607.5 mm with the 60-minute maximum precipitation of 80.5 mm (Oct. 12, 19:30 to 20:30) is mentioned (AMeDAS: Hippo Observatory). In

particular, the 12-hour rainfall (517.5 mm), observed by the Observatory, was over two times the existing maximum rainfall. As another factor, the distribution of granites and granodiorites in the affected area is considered, which are also distributed in the areas of sediment / flood inundation caused by the 2018 West Japan Heavy Rain Disaster and the 2017 North Kyushu Heavy Rain Disaster.

As an activity of TEC-FORCE, etc., NILIM and PWRI have conducted helicopter and field surveys immediately after disaster occurrence in Miyagi, Gunma, Iwate, Fukushima, Kanagawa, and Chiba and gave technical advice, etc. concerning emergency measures and warning / evacuation against further rainfall.

## (2) Results of the survey on the Uchi River basin (Marumori-machi, Igu-gun, Miyagi-ken)

The Uchi River is a right-bank tributary in the downstream of the Abukuma River and has the basin area of 105.84 km<sup>2</sup>. Regarding geology, granites and granodiorites are partially distributed in the upstream area but basalts and metamorphic rock are generally distributed. The Uchi River is divided into 3 rivers just upstream of the joint with the Abukuma River, which are called Uchi River, Gofukuya River, and Shin River in the order from east. According to the airborne survey, riverbed and bank erosion and small slope failure frequently occurred in the midstream of each tributary area and there were also slopes in some areas where many collapses occurred dendritically. The collapses are considered mainly shallow landslide. In the flat ground area at the valley exit of each of the three branch rivers, the original river channel was clogged by sediment in each area and occurrence of flood damage was also confirmed. The damage was most outstanding in the Gofukuya River, where the original channel was completely clogged at the time of the field survey and the flow channel changed in some sections (Photo 6). Sediment begins to deposit remarkably at the valley exit of the Gofukuya River. The riverbed of the section valley bottom plain, extending about 700 m, rose. In the flat ground, the area of sediment deposit spread across the Prefectural Road No. 45 in the direction of the right bank of the original channel, which shows the occurrence of flood. The deposited sediment includes few large stones and seems to be sediment of granite origin mainly consisting of sand. Flow of driftwood was also confirmed.

In the midstream of the Gofukuya River, bank erosion or bank collapse occurred in most of the section where there are no bare rocks. In the Usudaira flat ground area (about 3 km from the Uchi River junction), the river channel was mostly clogged with sediment, which is considered to show the occurrence of sediment / flood inundation.



**Photo 6 Occurrence of sediment / flood inundation in the Gofukuya River (Oct. 17)**

Debris flow also occurred on the back slope in the left bank of the community and caused damage.

## 2.4 Damage that affected road performance

### (1) Outline of damage

The 2019 East Japan Typhoon caused damage affecting the road performance of road facilities in wide area. Fully blocked sections were 17 routes of the expressways, 63 sections in National Highways under the State's direct control, about 160 sections in National Highways under the control of prefectures, etc., and about 900 sections in prefectural roads, etc. In addition, some trunk roads have been affected for a long period, which has caused a major disruption to the traffic network.

NILIM and PWRI dispatched personnel based on requests from road administrators etc. to provide technical support. The following describes the damage to the Hounji Bridge, Unnojuku Bridge, and National Highway No. 138 and support activities.

### (2) Damage to road bridge

In the Hounji Bridge of the National Highway No. 20 (Otsuki-shi, Yamanashi), two bridge piers that were supported by the spread foundation subsided and tilted and the road was blocked due mainly to the subsidence of the girders that were supported by these piers.



**Photo 7 Giving technical advice (Oct. 21)**

We conducted a field survey on October 21 upon request from the Kanto Regional Development Bureau and gave technical advice on the status assessment and emergency restoration method of the bridge after the damage (Photo 7).

The Unnojuku Bridge (Tomi-shi, Nagano), located on

the Shiratori Jinja Line of the municipal road, is a two-span continuous girder bridge crossing over the railroad of Shinano Railway. Because the revetment and levee were eroded by rise of water in the Chikuma River, A2 abutment fell down and the ground on the side of the spread foundation of P1 pier was washed away. In response to the request of Nagano-ken for technical support in such status of damage, we conducted a field survey on October 17 and gave technical advice on emergency recovery, etc.

### (3) Road damage by slope failure

On the National Highway No. 138, a natural slope at Hakone-machi, Kanagawa, collapsed about 180 m upward the road (oblique distance along the slope) and the traffic of the section including this spot was blocked. In response to the request from Kanagawa-ken, we conducted a field survey on October 26 and gave technical advice on the mechanism of slope failure and emergency recovery of the road (Photo 8).



**Photo 8 Field survey on National Highway No. 138, Hakone-machi. (Oct. 26)**

## 2.5 Damage to buildings etc.

NILIM and BRI conducted a field survey in order to grasp the damage to buildings etc. in Chiba-ken and the Tokyo island area by the strong wind of the 2019 Boso Peninsula Typhoon and to buildings etc. in Ichihara-shi, Chiba, by the tornado by the 2019 East Japan Typhoon.

### (1) Damage by the 2019 Boso Peninsula Typhoon

#### (1) Damage in Ichihara-shi, Futtsu-shi, Kyonan-machi, Minami-Boso-shi, and Tateyama-shi, Chiba

In the Ichihara City Hall, a total of 24 glass panels were broken in the 2nd Government Building and the City Council Building and, water leakage occurred at several spots in the indoor ceiling, etc. In the 2nd Government Building, 3 glass panes at the south entrance were broken and the wind blew into the Office Building and caused the damage of breakage to the glass on the north side.

As for types of damage to houses, there were breakage of windowpanes, come-off of roof tiles and other roofing, scattering of wooden roof truss (Photo 9), partial come-off, scattering, etc. of exterior wall finishing material (lath mortar, etc.). Of the above,

relatively major damage was selectively caused to those comparatively aged, those located along the coast, those of which component parts considerably deteriorated or suffered termite damage, etc.



**Photo 9 Scattering of the roof truss of a wooden house (Sep. 12)**

Next, as types of damage to low-rise stores, there were come-off / fall of fittings and exterior walls facing outside, come-off / scattering of eaves ceiling and exterior wall finishing material, scattering of wooden roof truss, etc. There was also a case where it is considered that the eaves ceiling came off and strong wind blew in and damage expanded to the indoor ceiling finishing material.

### (2) Damage to Kozushima-mura and Niijima-mura in the Tokyo Oshima Branch Office

Scattering of exterior wall material and roofing material was confirmed with houses, stores, warehouses, etc. Affected buildings include wooden ones, RC and CB structure, and masonry construction with wooden roof. In addition, some windowpanes and art works were broken in the art museum of Niijima-mura.

### (2) Damage by the tornado related to the 2019 East Japan Typhoon

As damage to houses, two cases where the upper structure fell down or scattered were confirmed. In both cases, the house aged more than 50 years. As damage other than collapse of super structure, etc., there were damage to the openings and exterior walls, scattering of wooden roof truss, come-off / scattering of tiles, deformation of the fittings facing outside, etc. (Photo 10) There was also a case of damage expansion where the fittings of storm shutters, etc. were damaged by collision of flying objects and the wind blew into the room, although the storm shutters were closed to prepare for approach of the 2019 East Japan Typhoon.



**Photo 10 Damage to the roof, openings, etc. of a house (Oct. 15)**

## 2.6 Damage to harbor facilities

NILIM and PARI conducted a field survey on the damage by the 2019 Boso Peninsula Typhoon to the Yokohama Port Honmoku Futo district and Kanazawa district (Fukuura and Sachiura). Both districts are considered to have suffered damage from the high waves. The following describes the situation of damage in each district.

### (1) Yokohama Port Honmoku Futo district

The superstructure of the east side revetments in the Yokohama Port Honmoku Futo district collapsed intermittently about 200 m in length. Since all the superstructures collapsed to the inland side, high waves are considered to be the cause (Photo 11). In addition, the container terminal was inundated and part of the fence collapsed. According to the trace of inundation, the inundation depth at the container terminal seemed to have been about 1m.



**Photo 11 East side revetments in the Honmoku Futo district (Sep. 14)**

### (2) Yokohama Port Kanazawa district (Fukuura and Sachiura)

East side revetments of Fukuura and Sachiura in the Yokohama Port Kanazawa district suffered damage, and the superstructure of the revetments collapsed intermittently about 600 m in Fukuura and about 230 m Sachiura. In some area, subsidence of the revetments was also confirmed. Since all the superstructures collapsed to the inland side, high waves are considered to be the cause.

In the back of revetments of Fukuura and Sachiura is an industrial complex, where many plants etc. are

located, and the whole area of these industrial complexes were flooded. According to the trace, it seems that sea water flew into the back a maximum of 800 m away from the revetments and that the inundation depth was a maximum of about 2 m near the revetments of Fukuura (Photo 12).



**Photo 12 Back of the Fukuura revetments in the Kanazawa district (Sep. 12)**

## 3. Postscript

Disasters caused by the 2019 Boso Peninsula Typhoon are characterized by wide-area damage to buildings, etc. by storm and to facilities by fallen trees, flying objects, etc. Further, the disaster by the 2019 East Japan Typhoon was such an extremely extraordinary and devastating disaster that it was designated as a "specific extraordinary disaster." The Typhoon caused enormous damage to the life and business in the affected areas as well as a large number of victims because water / sediment disaster and wind damage including house collapse occurred simultaneously and frequently in wide area and traffic and life line were widely blocked.

We are going to grasp the actual status of damage and solve technical issues in order to contribute to the restoration of affected facilities and the improvement of safety against disasters by typhoons together with the institutions concerned.

### Acknowledgement

In conducting the emergency survey and completing the survey report, we owe much gratitude to the great cooperation extended by the people of the organizations and affected buildings concerned in spite of their busy schedule for disaster response, including MLIT, Tohoku, Kanto, and Hokuriku Regional Development Bureaus, Iwate-ken, Miyagi-ken, Fukushima-ken, Ibaraki-ken, Tochigi-ken, Gunma-ken, Saitama-ken, Chiba-ken, Kanagawa-ken, Niigata-ken, Yamanashi-ken, Nagano-ken, Yokohama-shi, and Ichihara-shi. We sincerely appreciate their cooperation.