Completion Report Indonesia Internship September 1-12, 2013

Organized by Environmental Diplomatic Leader (EDL) Education Program

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Indonesia Internship

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Master's Program in Environmental Sciences
Doctoral Program in Sustainable Environmental Studies
Graduate School of Life and Environmental Sciences
University of Tsukuba

Preface

This report describes the activities and learning outputs from the EDL Indonesia Internship conducted during September 1-12, 2013. This internship was carefully designed as a field survey oriented program with a particular focus on volcanic eruptions, sediment disasters, and water resources management in Yogyakarta and the Mt. Merapi area. The internship was implemented jointly with Universitas Gadjah Mada (UGM).

Participants attended classes by UGM counterpart professors and an expert from the Ministry of Public Works to learn about volcanic and sediments disasters, water channel shifts, sand mining, and data analysis. Participants from Tsukuba University and UGM counterpart students conducted joint field surveys on sabo (sediment control) dam functions and water sources and quality.

On the last day, participants presented their findings based on field data analysis to UGM counterpart professors and students to wrap up the internship. They received a high evaluation for their presentation that elaborated the natural and socio-economic situation in the Merapi area on dynamic changes in sabo functions and water resources. They also received valuable comments on improving their survey and analysis methodology.

This internship was designed and implemented as a part of strengthening SUSTEP (Sustainability Sciences, Technology and Policy) collaboration with UGM. We sincerely appreciate our UGM counterparts, Professor Istiarto, Professor Rachmad Jayadi, Professor Djoko Legono, student assistants (Mr. Hatta Putra, Mr. Harold Laski, Ms. Isora Dewanti, Mr. Aditya Riski Taufani, and Ms. Dwi Indriastuti) for their generous guidance and support to enable this internship so successful.

EDL Indonesia Internship Instructor Team

Naoko Kaida, Norifumi Hotta and Kuniaki Miyamoto

Table of Content

List of Participants and UGM Counterparts

Participants of the Indonesia Internship

Supervisors
Dr. Naoko Kaida, Assistant Professor
Dr. Norifumi Hotta, Associate Professor
Dr. Kuniaki Myamoto, Professor

Students
Liu Junping, Doctoral student
Tran Dang An, Master's student
Naoyuki Shibayama, Master's student
Mariko Furukawa, Master's student
Haruka Tsunetaka, Master's student (EDIP Program)
Tomoharu Kubo, Master's student (EDIP Program)

Counterpart supervisors and student assistants at Universitas Gadjah Mada (UGM)

Dr. Istiarto, Professor
Dr. Rachmad Jayadi, Professor
Dr. Djoko Legono, Professor
Dr. Dibyo Sarutro, Professor
Dr. Pak Bambang, Professor
Dr. M. Zaki Hidayat, Professor
Dr. Adam Pamudji Rahaesjo
Dr. Ahmad Rifa'I, Associate Professor
Dr. Ir.Bambang Suhendro, Professor
Dr. Suprapto Siswosukarto, Professor
Mr. Hatta Putra, Master's student
Mr. Harold Laski, Master's student
Ms. Isora Dewanti, Master's student
Mr. Aditya Riski Taufani, Master's student
Ms. Dwi Indriastuti, Master's student
Ms. Sisca
Ms. Diana
Mr. Prianto
Mr. Trianingsih

Schedule

Date	Activity
September 1	Arrival at Yogyakarta, Indonesia
September 2 (Day 1)	Courtesy call to the Department of Civil Engineering, Faculty of Engineering, Universitas Gadjah Mada / Laboratory visit / lectures by UGM professors / preparatory study presentation / field survey preparation
September 3 (Day 2)	Lecture by UGM professor Field survey in Putih River
September 4 (Day 3)	Lecture by the Ministry of Public Works official Field survey in Kuning River /Kinaharjo Village
September 5 (Day 4)	Field survey in Gendol, Opak, Putih Rivers
September 6 (Day 5) and September 7 (Day 6)	Field survey in Boyong/Code River / site visit to Borobudur and Prambanan
September 8 (Day 7) and September 9 (Day 8)	MSD Workshop (including site visit to Wonogiri Reservoir)
September 10 (Day 9)	Data analysis and presentation preparation
September 11 (Day 10)	Visit to IPAL wastewater treatment plant / wrap-up presentation and discussion Departure from Yogyakarta
September 12	Arrival at Narita

1

Daily Activity Records

Field surveys in Yogyakarta and Mt. Merapi area

Day 1. Lectures and lab visit at UGM

September 2, 2013

1.1.1 Meet counterparts

On the first day of our stay in Yogyakarta, we went to UGM (Universitas Gadjah Mada), located in the near city center of Jogjakarta. Jogjakarta is called “Student city” because more than 100 universities are there. We met the professors of Civil and Engineering Department, Faculty of Engineering in UGM and introduced each other (Fig 1.1.1). They kindly explained about their university and department. The Civil and Engineering Department was established in 1946, and they study about volcano, landslide, disaster, earthquake, etc. Also, there were two students who came from Ehime University for research.

Fig 1.1.1 Meeting with UGM professors

1.1.2 Lecture from MPBA

Lectures were given by MBPA (Civil and Environmental Engineering) instructors in the hydraulics laboratory classroom. Through this internship, this room was used to take some lecture, prepare for field survey, data analysis, and presentation. On Day 1, we had a lecture from Dr. Agung Harijoko and Dr. Ahmad Rifa’i (Fig 1.1.2). The lectures were about eruption of Mt. Merapi and effective utilization of volcanic ash for soil improvement. The students of the MPBA Program also took this lecture together.

1.1.3 Campus orientation

We saw around the hydraulics laboratory. There were big equipments to create waves and some models of water flow (Fig 1.1.3). Also, they analyze water quality such as BOD, COD and nitrate.

Fig 1.1.2 Lecture by Dr. Rifa'i

1.1.4 Presentation of pre-study and field activity preparation

We made a presentation about our each research topic and pre-study about Mt. Merapi (Fig 1.1.4). We received a lot of questions and comments about our research from professors and students. They told us we could borrow the equipment to measure some water quality. The field survey from next day was arranged to visit Putih River for sediments, Kuning River for spring and several rivers for stream water.

Fig 1.1.3 Hydraulics laboratory facilities

Fig 1.1.4 Preparatory study presentation

Day 2. Field activity in Putih River

September 3, 2013

1.2.1 Lecture from Prof. Isiarto

The content of this lecture was about data processing techniques and how to use statistics and numerical methods effectively. We learned a lot from this lecture about description of statistics. Also, some observation equipment were introduced and it was very helpful for us to understand the mechanism of these equipments.

1.2.2 Field activity in Putih River

In this day, we visited two locations in Putih River, upstream and mid-stream. There was no stream water in the upstream of Putih River. There, we also visited a big sabo dam which was constructed in 1992 (Fig 1.2.1). Sabo dams in Putih River were all damaged by the eruption in 2010, but it was repaired soon after. There was stream water in mid-stream of Putih River (Fig 1.2.2), so we took water sample.

Fig 1.2.1 Sabo dam in upstream of Putih Ruver

Fig 1.2.2 Stream water in mid-stream of Putih River

Day 3. Field survey in Kuning River

September 4, 2013

1.3.1 Lecture in UGM

Fourth day of our stay in Indonesia began with a lecture about water management by Mr. Dibyo Saputro, a government officer from the Ministry of Public Works. Mr. Dibyo gave an informative lecture on water resources management in this region including rural drinking water associations called PAMDes (Paguyayuban Air Minum Desa). According to his lecture, main water resources around Yogyakarta are spring water. Groundwater was used only during the eruption phase and it was supplied by gravity not by pumping.

1.3.2 Field survey (Kuning River)

Kuning River has a very important role in terms of water supply. There are many pipelines in the upper stream of the river. By using these pipelines, water is supplied to not only local residents along this river but also city areas including Yogyakarta and Saleman.

We also found a trace of erosion by lahar flow (Fig 1.3.1). There are many sabo dams along the river.

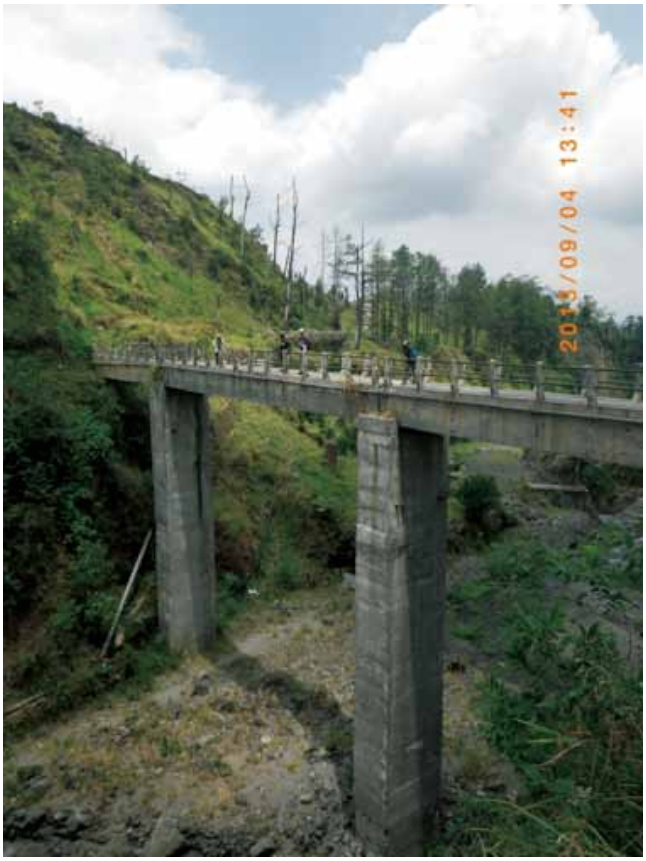


Fig 1.3.1 Erosion due to lahar flow

Fig 1.3.2 Spring started flowing after the 2010 eruption

The upper stream area has three major springs. The volume of the flow significantly increased after the eruption in 2010 (Fig 1.3.2). It is one of the positive effects by volcanic eruption. There was an area that stones were colored yellow by metal ion (Fig 1.3.3). That is why this river is called “Kuning” River. The word “kuning” means yellow in Indonesian language.

1.3.3 Field survey (Kinahrejo Village)

After our visit to Kuning River, we went around in Kinahrejo Village by jeep. (Fig 1.3.4)

Kinahrejo was seriously damaged by the volcanic eruption in 2010 (Fig 1.3.5). Many people were killed at that time. We also visited a shelter to escape from pyroclastic flow (Fig 1.3.6). Two persons were killed in this shelter due to the eruption in 2010. It is conidered that they might have died because of the heat before the eruption stopped.

Surprisingly, there were many tourists visiting Kinahrejo Village. What was more surprising to us is that local business for tourists had started in less than one year after the eruption.

Fig 1.3.3 Yellowish stone

(left top)
Fig 1.3.4 On the way to Kinahrejo by jeep
(right)
Fig 1.3.5 Motorbike damaged by volcanic eruption
(left bottom)
Fig 1.3.6 Shelter to escape from pyroclastic flow

Day 4. Field survey in Gendol, Opak, and Putih Rivers

September 5, 2013

1.4.1 Field survey (Gendol River)

We visited two sites, one is upper downstream area and the other is upper stream area. First, we went to the downstream area. There was also a sabo dam. We were told that it is built in 1958 and the oldest one in Java Island (Fig 1.4.1). At this point spring water had come out.

We then visited upper stream area (Kepuharjo). There was no water but lots of sediments. Many people were working there for mining sand (Fig 1.4.2).

1.4.2 Field survey (Opak River)

Opak River is located next to Gendol River. Many of the bridges above this river were destroyed by lahar flow at the time of the eruption in 2010. Some of the destroyed bridge were reconstructed. In this area, river water is pumped up for watering paddy fields beside the bank of Opak River (Fig 1.4.3).

1.4.3 Field survey (Putih river: downstream area)

We found lots of “humble plant”, *ojigiso* in Japanese in the survey site in Putih River. In Indonesia humble plants were found everywhere. Its Indonesian name is “*putri malu*”, which means “a shy girl” (Fig 1.4.4). This area is close to city area. Many local children were playing in the river (Fig 1.4.5).

1.4.4 Field survey (Prongo-Putih confluence)

Fig 1.4.1 Rhe oldest sabo dam in Java
Fig 1.4.2 People working for mining sediments
Fig 1.4.3 Opak River

We conducted field surveys mainly in rivers coming from Mt. Merapi, but only Prong River flows from a different mountain in Central Java. We found larger farm lands than any other places we visited (Fig 1.4.6). This is because the amount of the flow in Prongo River is very large (Fig 1.4.7), while that of Putih is much smaller (Fig 1.4.8).

Fig1.4.4 *putri malu*,humble plant

Fig1.4.5 Local children playing in Putih River

Fig1.4.6 Large farm land near the Prongo-Putih confluence

Fig1.4.7 Prongo River

Fig1.4.8 Putih River

Day 7 & 8. Wonogiri Reservoir and MSD Workshop

September 8 & 9, 2013

One of the most interesting activities during our internship is that we had a good chance to join the 4th International Workshop on Multimodal Sediment Disaster (MSD) which was held by UGM, Kyoto University, University of Tsukuba and the MSD Network for two days on the 8th and 9th September 2013. As part of workshop activities, we visited Wonogiri Reservoir (Fig 1.7.1), the biggest project on water resource management in Java Island, supported by JICA, attended oral presentations of many specialist from Japan, Malaysia, Nepal, Philippines, Indonesia and so on (Fig 1.7.2).

This conference gave us a lot of unique information and knowledge on various aspects of environmental issues such as flooding, lahar flow, landslide, and community based approaches to adapt natural disasters. More importantly, we had good opportunities to know that how scientific research works are presented and discussed by many well known researchers on the environmental and disaster related issues, relating to volcanic eruption in Merapi.

Fig 1.7.1 Site visit to Wonogiri Reservoir

Fig 1.7.2 Presentation on landslide and sediment by Dr. Hotta

Day 9 & 10. Field survey data analysis and presentation

September 10 & 11, 2013

After finishing field investigation, we prepared a presentation about findings from field survey based on survey data and observation on September 10th. On the next day afternoon, we gave a wrap-up presentation on this internship in front of our internship supervisors, the counterpart UGM professors and students. Fig 1.9.1 shows one of our group members presenting on his part about water resources in the Merapi watershed.

The last two day sessions as a series of data analysis, preparation for reporting, presentation and discussion was really exciting experiences to us. We sincerely appreciate guidance and supports by our supervisors, UGM professors and friends.

Fig 1.9.1 Group presentation on field survey results

Day 10. Visit to IPAL municipal wastewater treatment plant

In order to understand on urban water environmental management in Yogyakarta City, we visited a wastewater treatment plant called IPAL and had a very nice discussion with its officers (Fig 1.10.1).

This wastewater treatment plant was built under supporting by Japanese International Cooperation Agency (JICA) in 1994 and started its operation in 1996. The main function of this plant is to treat wastewater from Yogyakarta City. Currently, however, it treats both wastewater and human solid waste from this city. Through discussion with the officers here, we understood the issues of wastewater management and treatment in Yogyakarta City.

Fig 1.10.1 Discussion with staffs about IPAL wastewater treatment plant

2

Research Reports

Field survey and analysis

2.1 Field survey and analysis: water and sediment issues

2.1.1 About field survey

We conducted field survey for four days, from September 3rd to 6th in the area of Mt. Merapi. Mt. Merapi is one of the most active volcanoes in the world, located in Central Java Province with a height of 2,968 m.

Eruptions produce a tremendous volume of volcanic ash and also induce pyroclastic flows due to collapse of lava dome, resulting in disaster in downstream areas. There have been about 70 recorded eruptions since 1578 with a mean interval of less than 10 years. Recently, a remarkable big eruption occurred in 2010.

The locations of field survey are shown in Fig 2.1.1 and Table 2.1.1. The surveys were focused on rivers. EC (electrical conductivity), pH, TDS, salinity, discharge rate were measured and water samples were taken in situ. The water samples were analyzed for stable isotopes (δ18O, δD) and solute constituents (Cl-, NO3-, SO42-, K +, Mg2+, Na+, Ca2+, SiO2) in laboratory. Nine water samples were taken, seven of which are river water and the other two are

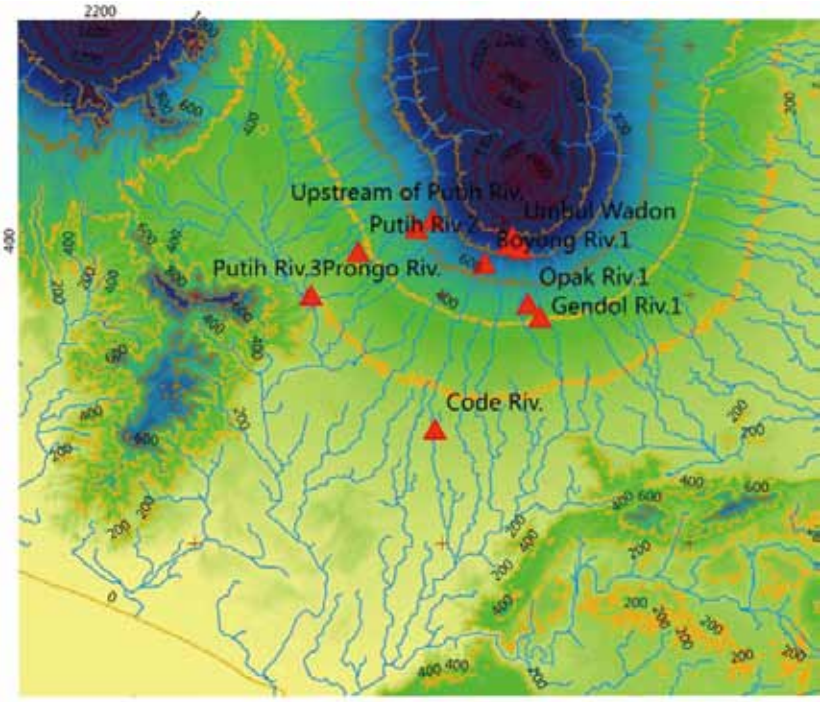


Fig 2.1.1 Location of the field survey

Name	Date	Time	Latitude	Longitude
Upstream of Putih Riv.	3-Sep-13	14:35	7.576	110.369
Putih Riv.1	3-Sep-13	16:00	7.584	110.354
Kuning Riv.1	4-Sep-13	11:57	7.599	110.436
Umbul Lanang	4-Sep-13	12:47	7.592	110.440
Umbul Wadon	4-Sep-13	13:05	7.593	110.440
Kuning Riv.2	4-Sep-13	13:30	-	-
Kinahrejo Villege	4-Sep-13	16:15	7.603	110.448
Gendol Riv.1	5-Sep-13	9:39	7.663	110.464
Opak Riv.1	5-Sep-13	12:18	7.651	110.454
Putih Riv.2	5-Sep-13	14:50	7.605	110.302
Putih Riv.3	5-Sep-13	16:33	7.644	110.260
Prongo Riv.	5-Sep-13	16:45	7.644	110.260
Boyong Riv.1	6-Sep-13	10:15	7.616	110.415
Code Riv.	6-Sep-13	11:40	7.763	110.371

spring water nearby river.

2.1.2 Rivers

Putih River is located in the most western part in the rivers we visited this time. Intensive lahar flow occurred in this river after the eruption in 2010. Since there are a lot of volcanic sediments, people mine them to sell for the material. The volcanic sediments can be used as good construction materials.

We visited the following four locations in this river, shown in Fig 2.1.2.

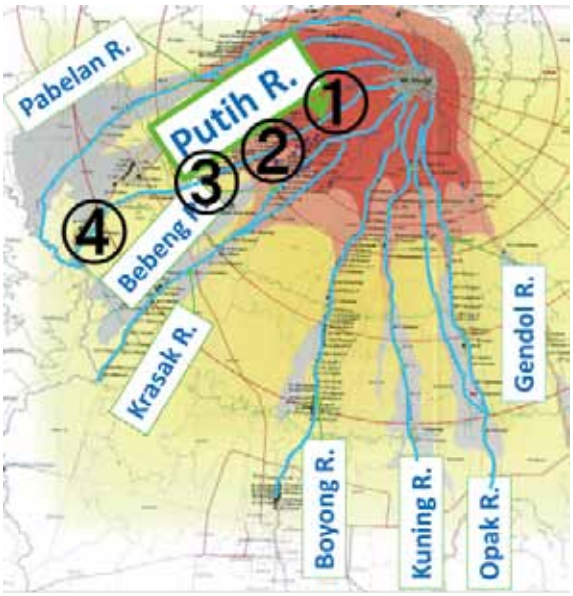


Fig 2.1.2 Location of Putih River

(1) Upstream of Putih River (Fig 2.1.3)

No stream water. Instead, there were a lot of rocks and sediments by volcanic flow. The water might flow under the sediments. Sand mining is especially active in this location (Fig 2.1.4).

Fig 2.1.3 Upstream of Putih River

Fig 2.1.4 Sand-mining in upstream of Putih River

(2) Putih River 1

Stream water can be seen in the downstream from this location. A camera to judge the stream whether water or lahar and level indicator are set on the riverside (Fig 2.1.5).

(3) Putih River 2

Fig 2.1.5 Sand-mining in upstream of Putih River

Fig 2.1.6 Sand-mining in upstream of Putih River

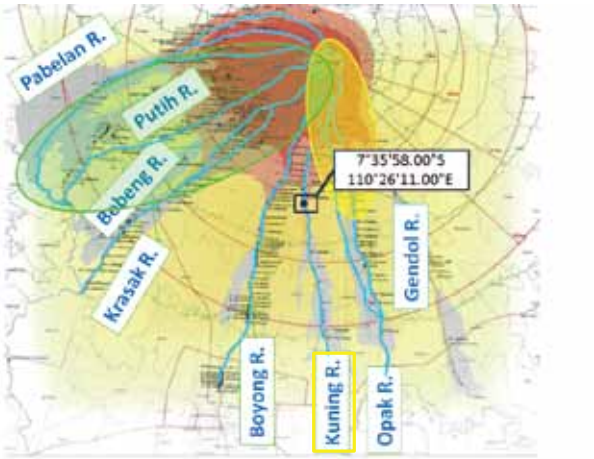


Fig 2.1.7 Location of Kuning Rever

(4) Putih River 3 and Progo River (Fig 2.1.6)

Putih River and Progo River converge in this location. Volcanic sediments can be found also in this area. The influence of volcanic eruption might have reached this area.

There was no stream water in upstream and appears in downstream. It indicates the discharge from groundwater to river water.

2.1.3 Kuning River

As part of our field investigation, we visited Kuning River and conducted investigation on September 5th 2013. Kuning River is well known as one of the main rivers in Mt. Merapi as shown Fig 2.1.7 below.

With its 50 km length, Kuning is one of the three rivers running through Yogyakarta City. Generally, the river is quite small, with 50-80m width but very deep, 30-60m, and the river bed has lots of rocks and

Fig 2.1.8 Kuning riverbed characteristics, indicating effects of volcanic eruption in 2010

Fig 2.1.9 Spring water is a main water source in Kuning River

Fig 2.1.10 Complex pipeline water supply system installed in Kuning River

Fig 2.1.11 Hydro-pump for transferring water to local communities

sediments as shown in Fig 2.1.8 as a result of sediment transportation from Mt. Merapi to downstream after the volcanic eruption in 2010.

During the survey, we measured some parameters such as EC, TDS and took samples to analyze ion concentration, stable isotopes. It is believed that Kuning River plays a very important role in supplying water not only to local residents living along with this river but to Yogyakarta City. The spring water is dominant in this area as shown Fig 2.1.9.

Fig 2.1.12 Forest disappeared after the 2010 eruption

The main discharge here is groundwater from upstream, as presented in Fig 2.1.10, with many pipeline systems connected with spring to obtain fresh water. This system is however not necessarily safe because most of them were once damaged after lahar flow due to the 2010 eruption.

Interestingly, a hydro-pump, which does not require any electricity for its operation (Fig 2.1.11), is used to supply freshwater for different villages which are located at the high elevation and are very difficult to get freshwater. This pump is very unique and effective in case of no energy supply available like this location.

Further interesting findings about Kuning River are that its topography is very steep, or sharp, and that most of the forest here was destroyed due to the volcanic ash in the 2010 eruption (Fig 2.1.12). From the viewpoint of water resource management, this condition is of very severe issue because Yogyakarta is located in the high rainfall region and this, coupled with the steep topography, leads to more erosion and a large volume of rainwater flow to downstream without recharging into groundwater. This issue should be carefully considered in order to effectively manage the natural resources in this river area.

2.1.4 Boyong/Code River

We took water sample at two locations in Boyong River (Fig 2.1.13). One is in the upstream of Boyong River, the 600m above sea level, where the riverbed is covered by sediments and only a small volume of surface water exits in the form of stream, with the biggest width of 1.8m. Another is in the downstream of Boyong River (Code River), below 600m above sea level, where a large quantity of river water is available including the agriculture drainage. The biggest width of Code River is 25m.

Compared with the EC value and discharge of the upstream of Boyong River, Code River represents higher values about both of the two parameters, indicating that lahar-related matter increases in the downstream and drainage is very dense below 600 m above sea level (Franck Lavigne, Jean-Claude Thouret, 2002).

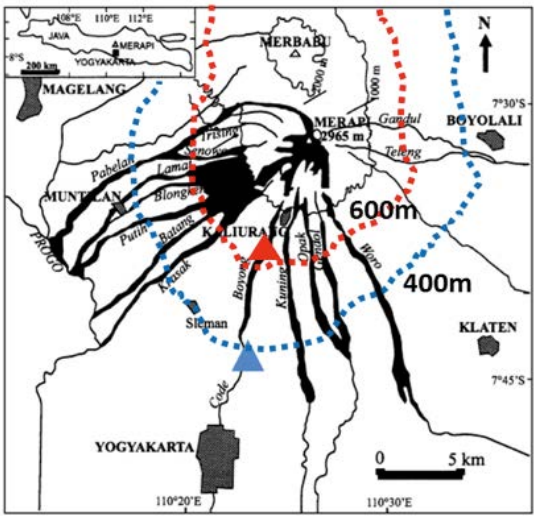
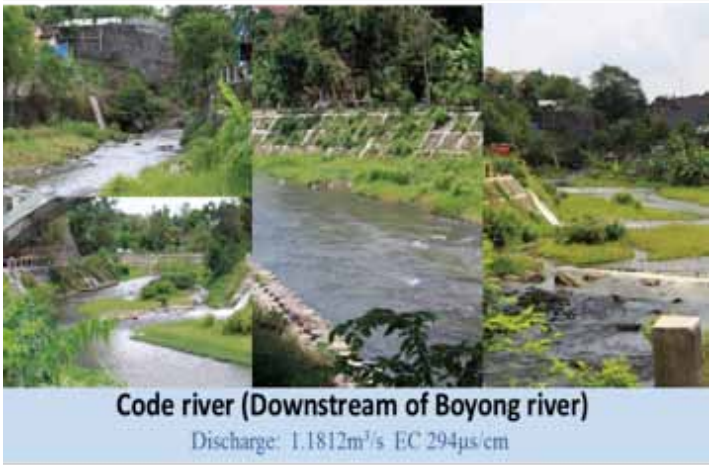


Fig 2.1.13 Water sampling locations in Boyong/ Code River



2.1.5 Gendol River

Gendol River is located in south-east part of Mt. Merapi (Fig 2.1.14). We visited two sites: one each in the upper stream area and downstream area. The upper stream area was completely covered with sediments and many people were working in sand-mining (Fig 2.1.15). The sand produced (simply mined) from here is used for construction materials across the country. In the downstream area, spring water was observed (Fig 2.1.16). We therefore measured water temperature, EC and TDS and took water sample in the downstream area. Its EC value was significantly higher compared with other rivers we surveyed. We will further elaborate this interesting finding in the following Discussion part.

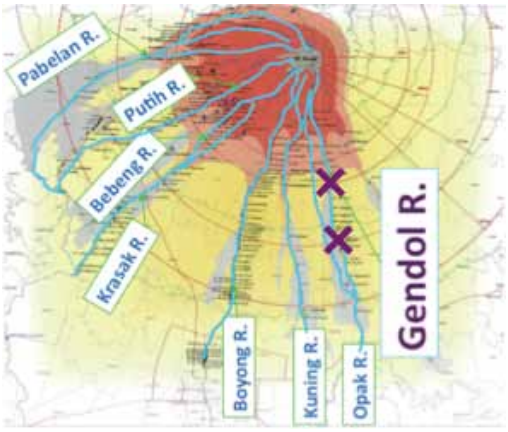


Fig 2.1.14 Location of Gendol River


Fig 2.1.15 Upper stream area of Gendol River


Fig 2.1.16 Downstream area of Gendol River

2.1.6 Results

Result of measurement and analysis are shown in Table 2.1.2.

Table 2.1.2 Result of measurements and chemical analysis

Name	Salinity	EC	TDS	Temp	Cl^-	NO_3^-	SO_4^{2-}	Na^+	Mg^{2+}	K^+	Ca^{2+}	HCO_3^-	SiO_2
	‰	µS/cm	ppm	℃	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Upstream of Putih Riv.	-	-	-	-	-	-	-	-	-	-	-	-	-
Putih Riv.1	-	-	-	-	22.01	1.12	47.76	17.87	12.51	7.14	33.69	80.52	15.75
Kuning Riv.1	0.0	222	106.2	25.5	8.75	1.42	19.41	14.06	5.60	3.86	39.59	73.20	18.51
Umbul Lanang	0.0	213	101.8	24.2	7.54	0.76	17.29	13.81	5.31	3.69	40.74	76.25	19.05
Umbul Wadon	0.1	267	128.4	22.4	15.37	2.92	27.60	17.26	7.39	4.79	37.73	76.25	17.64
Kuning Riv.2	-	-	-	-	11.25	0.76	21.33	14.84	7.20	4.12	33.25	73.20	15.54
Kinahrejo Villege	-	-	-	-	-	-	-	-	-	-	-	-	-
Gendol Riv.1	0.4	873	427	28.1	24.82	1.67	170.85	57.97	25.74	13.90	87.62	152.50	32.93
Opak Riv.1	0.0	228	109.3	31.4	4.38	1.71	8.34	13.78	5.78	6.78	21.60	109.80	43.89
Putih Riv.2	0.1	286	137.3	31.4	12.32	0.74	22.12	16.48	8.50	7.26	23.30	87.84	35.08
Putih Riv.3	0.1	332	159.7	-	16.27	0.86	22.43	20.29	9.86	9.40	26.67	113.46	36.27
Prongo Riv.	0.1	282	135.6	-	-	-	-	-	-	-	-	-	-
Boyong Riv.1	0.0	216	103.6	28.1	-	-	-	-	-	-	-	-	-
Code Riv.	0.1	294	141.3	29.2	-	-	-	-	-	-	-	-	-

2.1.7 Discussion: association between lahar and EC

The results of the field survey data analysis showed that EC values of Gendol are significantly high compared with other rivers we surveyed (Fig 2.1.17 and Table 2.1.3). According to the information and knowledge we obtained from our preparatory study and lectures by the UGM instructors, pyroclastic flow ran mainly into Gendol River in the sediment disaster which occurred after the 2010 eruption (Fig 2.1.18). Based on this information, we assumed that the high EC value and the amount of pyroclastic flow are related each other.

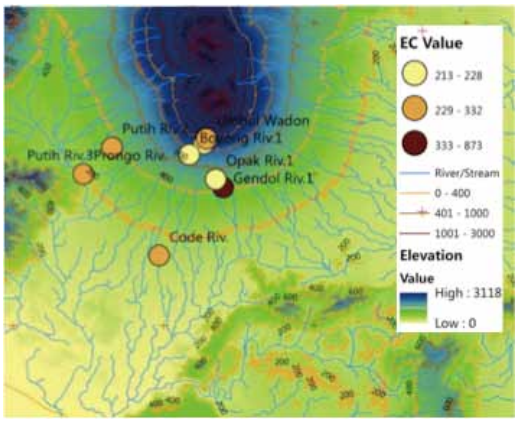


Fig 2.1.17 Spatial distribution of EC

Table 2.1.3 EC and HCO3 values in each river

River	EC (μS/cm)	HCO^3
Putih	309	1.54
Kuning	222	1.2
Gendol	873	2.5
Opak	228	1.8
Prongo	282	-
Boyong	216	-
Code	294	-

Using the data shown in Table 2.1.4, we developed a graph which illustrates the relationship between EC and lahar volume in the four river surveyed. According to Fig 2.1.19, these two values apparently have a strong positive correlation. Surprisingly, the correlation coefficient between the two variables is as high as 0.99. Taking into consideration the possible causality between the two variables, it implies that lahar volume influences EC values. In order to understand the association between the two factors more in detail, further research is needed.

Table 2.1.4 EC and lahar volumes in each river

River	EC (μS/cm)	Lahar Volume ($m^3 \times 10^6$)
Putih	309	8.2
Kuning	222	3.7
Gendol	873	24
Boyong	216	2.4

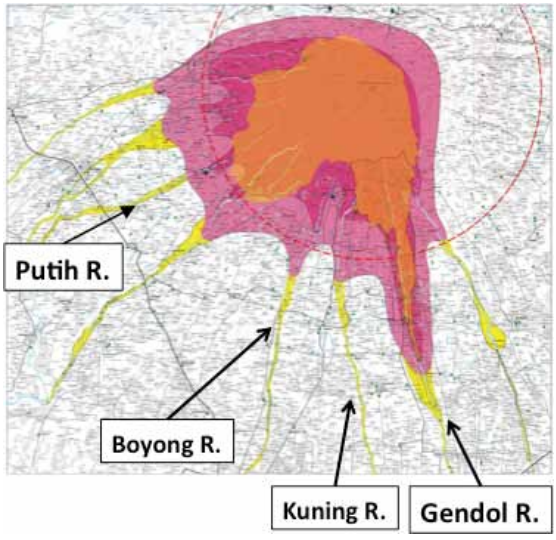


Fig 2.1.18 Pyrocrastic flow in Mt. Merapi (hazard map 2010)

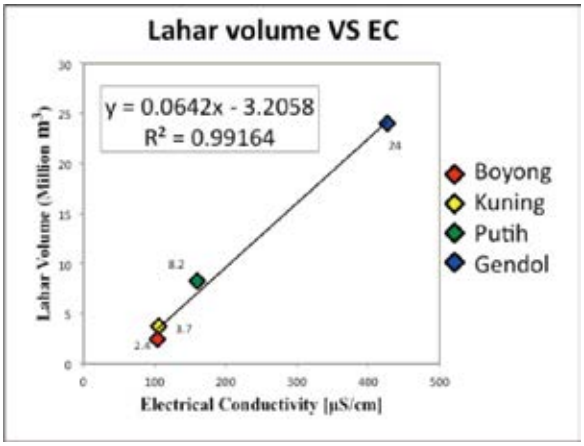


Fig 2.1.19 Relationships between EC and lahar volumes in each river

2.2 Municipal wastewater treatment

2.2.1 IPAL Water waste treatment

IPAL wastewater treatment plant covers around 6.7 ha and is located in the southern part of Yogyakarta City as shown in Fig 2.2.1. IPAL was built in 1994 based on a Rp 59 million funding of JICA and started its official operation in 1996.

The main functions of IPAL are as follows:

- Management, operation and maintenance of the sewerage system and wastewater treatment processes,

- Facilitate the infrastructure installation of wastewater treatment,

- Implementation of the monitoring and control on household wastewater,

- Implementation of empowerment in the management community of household wastewater, and

Fig 2.2.1 Location of IPAL wastewater treatment plant in Yogyakarta, Indonesia (Source: Google Earth, 2013)

- Evaluation and preparation of the implementation program, and execution of other duties according to the function and duties.

According to the official report 2012, the IPAL treats wastewater coming from a population of 62,015 in the three areas with around 14,329 connections as follows:

- Kabupaten Sleman: 795 connections

- Kota Yogyakarta: 12,804 connections

- Kabupaten Bantul: 432 connections

Domestic wastewater and human solid waste are directly put into the sewerage system through sewer pipelines connected with households without pretreatment as shown in Fig 2.2.2.

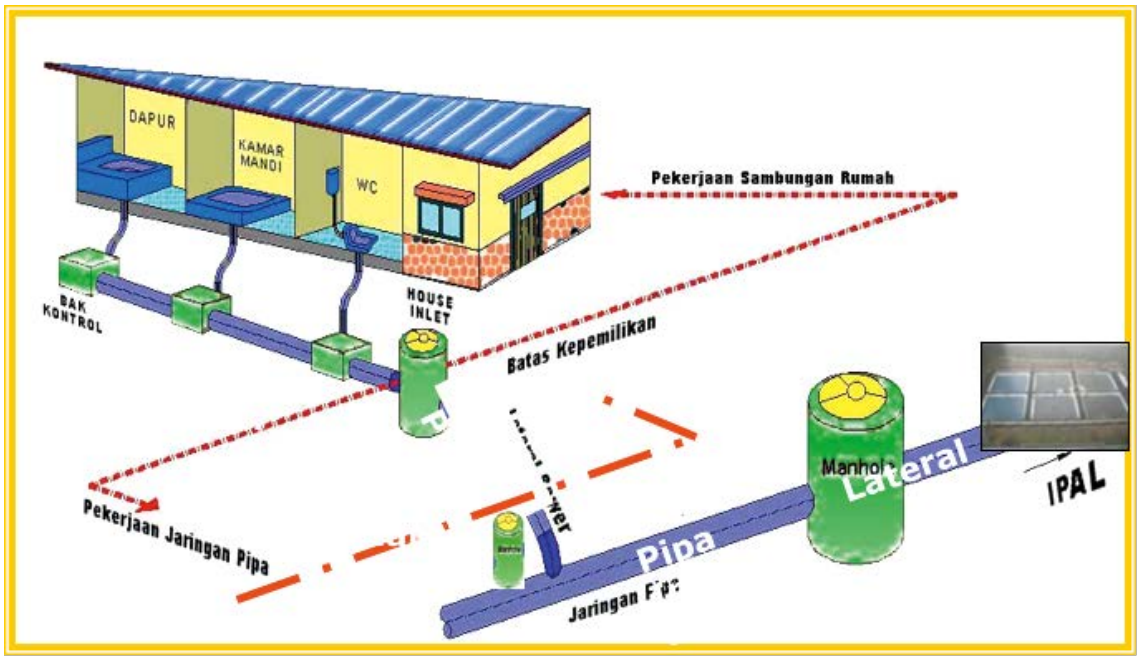


Fig 2.2.2 Sewerage system in Yogyakarta, Indonesia
(Sorce: IPAL, 2013)

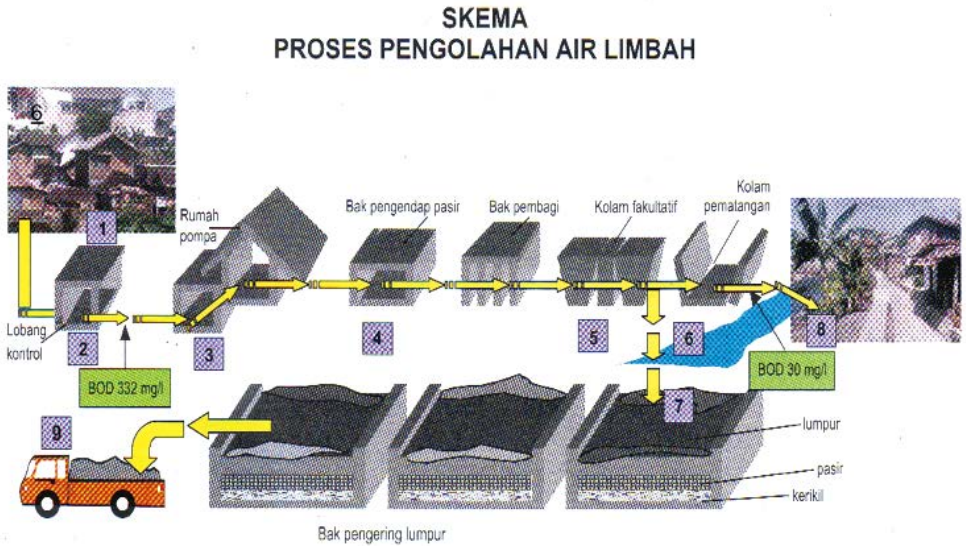


Fig 2.2.3 Comprehensive wastewater treatment processes at IPAL
(Source: IPAL, 2013)

The sewerage system was designed to transfer both wastewater and human solid waste to IPAL wastewater treatment plant where both kinds of wastewater are pumped into wastewater treatment processes and finally clean water is discharged into canal and river. These processes are shown in Fig 2.2.3.

Despite that all the connections discharges wastewater and human solid waste directly into the sewerage system, transferring such wastewater to IPAL water treatment plant is often difficult because most solid will be stored into pipelines and prevent water flow. Moreover, sometimes the connections or even sewerage pipelines somewhere can be broken, resulting in water and soil pollution. This situation is particularly not good for environment as we can see clearly in Fig.2.2.4.

Regarding the operation of IPAL, one issue we found is that this system is managed by the government budget without any additional revenue while many trucks can transfer human solid waste from surrounding areas, which are not connected to the sewage pipelines, to IPAL and freely take sediment products produced as a result of wastewater treatment. Economically, IPAL can charge a fee on trucks in order to obtain money by using official regulations to operate this system more effectively. However, officers of IPAL mentioned that it is very difficult at present because many can discharge wastewater directly into the environment. Therefore, one of the most important issues to solve this problem is that the local government should consider environmental laws and regulations and implement it successfully in reality.

Fig 2.2.4 Environmental issues related to wastewater connections and transportation
(Source: IPAL, 2013)

2.3 Summary

2.3.1. Water and sediment management

As a matter of fact, volcanic eruption in the Merapi watershed dominantly represents the natural disasters in Yogyakarta Province. Due to its very steep topography, high rainfall and significant impacts of volcanic ash, natural disasters become much more serious than other regions once they occur. As we mentioned above, the main water resources in this region is spring water, groundwater in upstream and surface water in downstream. The main threats to water source sustainability here are volcanic eruption productions such as volcanic ash, lahar flow coupled with an increasing volume of water usage, disposal of chemicals to land surface, discharge wastewater and waste into rivers. Sound water resources management practices are required to avoid such kinds of issues above and there needs to improve awareness on environmental protection when planning, implementation, using these water resources to ensure water quality and equitable share among all stakeholders. In order to meet these requirements, firstly it is necessary to establish the suitable environmental protection laws. Secondly, environmental monitoring systems needs to be installed in order to monitor and assess environmental pollution and service to water resources management.

One of the most important things related to watershed management practices is that sediment management. It is believed that sediment processes, especially lahar flow result in a lot of damages on environment and human life in this region. However, it also provides many valuable benefits for people in Yogyakarta region. Therefore, sediment management should be balanced between its positive and negative sides as follows: (i) build sabo dams to prevent and reduce effects of sediment transportation along the rivers; (ii) manage sand-mining and rehabilitating forests for sustainable resource use and avoid breaking river banks that may make lahar flow more hazardous in the future, and; (iii) establish natural disaster adaption based on communities awareness and supports from the government.

2.3.2 Natural disaster adaptation

What we felt through this internship is that Mt. Merapi has been providing great impacts on people’s life both positively and negatively since very long time ago. There are at least three types of impacts that can be counted as positive ones, namely, water supply, sand mining, and culture.

Water supply

As mentioned previously, there are three major springs in the upper stream area of Kuning River. The amount of water discharge from one of these springs significantly increased after the 2010 eruption .

Sand mining

Thanks to sediments brought by lahar flows, people can easily obtain materials for building construction. It furthermore means that local people who live along rivers or surrounding areas can easily get a job as a sand-miner.

Culture

Yogyakarta is known to have two famous ancient temples, Borobudur and Prambanan. The former is Buddhism and latter is Hindu. Both of the huge structures were built using volcanic rocks. This indicates that people have been benefited from Mt. Merapi since long time ago.

Needless to say, negative effects can never be forgotten. Apart from sediment-related disasters and water resources issues which we primarily focused on for our study, volcanic eruptions of Mt. Merapi per se destroy a lot of things including the natural environment and ecosystems, landscape and infrastructure and housing structures, and kill a number of people. Over 300 people were killed in the 2010 eruption.

Japan is a country of serious natural disasters as Indonesia and many other countries are. When we tackle these problems, we should thoroughly consider both positive and negative effects of disasters.