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学 位 論 文 要 旨
Dissertation Summary

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論 文 名:

Medical Geology in Artisanal and Small-scale Gold Mining Area
Polluted by Mercury, Northern Sulawesi, Indonesia

Artisanal and small-scale gold mining (ASGM) activities, their mercury emission and its impacts on environment and human health in the Gorontalo Province and Bolaang Mongondow region, Sulawesi Island, Indonesia were studied. Illegal gold mining occurs in many areas in this region but especially three areas: the Hulawa, Ilangata and Ilangata Barat subdistricts. Mining activities in the Hulawa subdistrict are the oldest (late 19th century AD) in the province. Recent ASGM begin in the early 1970s. ASGM in the Ilangata and Ilangata Barat subdistricts began five years ago. The activity level changes rapidly from time to time depending on gold production rumors. Women and children are involved in the gold mining processes. Female workers crush ore, process sediment wastes, and pan rivers. Children assist their mothers in these activities and play around the mining sites. Gorontalo Utara ASGM is estimated to produce approximately 286 kg of gold and emits approximately 858 kg of mercury into the environment annually. The impact that such large mercury emissions have on the environment and human health urgently needs to be assessed to reduce or avoid health problems and fatalities.

Mercury concentrations in the environment (river sediments and fish) and in the hair of artisanal gold miners and inhabitants of the Gorontalo Utara Regency were determined to understand the status of contamination, sources and their impacts on human health. Mercury concentrations in the sediments along the Wubudu and Anggrek rivers are already above the tolerable level declared safe by the WHO. Meanwhile, commonly consumed fish, such as snapper, have mercury levels above the threshold limit (0.5 µg/g). The mean mercury concentrations in the hair of a group of inhabitants from Anggrek and Sumalata are higher than those in hair from control group (the inhabitants of Monano, Tolinggula and Kwandang). The mean mercury concentration in the hair of female inhabitants is higher than that in the hair of male inhabitants in each group. Neurological examinations

were performed on 44 participants of ASGM miners and inhabitants of Anggrek and Sumalata. From the 12 investigated symptoms, four common symptoms are already observed among the participants, namely, bluish gums, Babinski reflex, labial reflex and tremor.

Working conditions in some ASGM in the southern part of the Gorontalo Province are not healthy, and may caused several infectitious diseases. Female workers involvement in ASGM brings more health problems on mothers and children. Small children are vulnerable to infectitious diseases. Scalp hairs were collected from 129 donors from Marisa, Tilamuta, Boliyohuto and Gorontalo City, kept for further analysis. The mercury contents of hair were determined using Particle Induced X-ray Emission (PIXE). The result is in general conditions of inhabitants and ASGM workers are already in alert level. The mercury level of inhabitants and ASGM workers in three regencies (Pohuwato, Boalemo and Gorontalo) are higher than control group (Gorontalo State University (UNG) teachers and students).

The concentration (in average) of mercury in scalp hair of inhabitant of Bolaang Mongondow region is slightly more than 5 $\mu\text{g/g}$ (the threshold of alert level according to HBM). Mercury in hair of Kotamobagu City inhabitants is the lowest in Bolaang Mongondow region and whole population of the studied area.

There is significant difference between concentration of mercury in hair of the subgroups in Bolaang Mongondow region and southern area of Gorontalo Province cases which are different to population of Gorontalo Utara regency. It is probably that Gorontalo Utara regency population are consume the same contaminated foods, which make them exposed to the mercury even they are living away from the highly contaminated areas.

Environmental assessments on river sediments of Tanoyan and Tobongon shows that, elevated mercury concentrations on river sediment are higher than safety guideline by EPA, and it is related with ASGM activities in the area. River water fish is having high mercury concentrations since it is living in the tailing pond.

Health assessments have been done on the Tanoyan and Tobongon inhabitants and miners show that Nystagmus is common disturbance found in the both ASGM sites. Four common disturbances (Bluish of gums, Ataxia, Nystagmus and tremor) found in Tanoyan miners while six disturbances (Nystagmus, Field of vision, Knee jer, Biceps reflex and sensory and tremor) were found among Tobongon miners.