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Mapping of Health Disorders Related to Mercury on Community around the Bone River, Gorontalo Province

Sri Manovita Pateda[a*], Yayu Indriati Arifin[b],Vivien Novarina Kasim[c]

[a]*Public Health Department, Sport and Health Faculty, State University of Gorontalo*

[b]*Geology Department, Mathematics, Physics and Science Faculty, State University of Gorontalo*

[c]*Nursing Department, Sport and Health Faculty, State University of Gorontalo*

[a]*Email: manovita.pateda@gmail.com*

Abstract

Health problems associated with mercury depend on the amount of Hg levels that enter the body and accumulate in it. Symptoms that arise from the mildest of paresthesia to more severe symptoms of ataxia, dysarthria can even cause death. This study aims to map health-related health problems of mercury in the Bone River, Gorontalo Province. The Bone River is a river in Gorontalo Province has been polluted by heavy metals mercury due to traditional mining activities that dispose of the mercury-containing mining process to the river water. The health disorders described from the mapping, indicating that the tremor neurological disorder is most significant, especially at sample point V (closest to the mining) with a positive sample percentage of 28.6%. This concludes that prominent symptoms in humans associated with mercury are neurologic symptoms, especially tremor (through nasal examination). Other symptoms are not specific. Further research is needed to conduct a deeper assessment of health problems in the community, especially associated with neurobehavior and neurocognition, both in adults and in children.

Keywords: Health Disorder; Mercury; ataxia symptoms; and dysarthria.

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* Corresponding author.

1. Introduction

The human body has a homeostatic ability to maintain a stable state of the body, as well as in controlling heavy metals. However, when excessive concentrations of heavy metals, both acute and chronic, it will give the effect of poisoning the body, which will automatically affect the disruption of homeostasis of the body. One of the heavy metal into current national and international issues as well as widely studied is the impact of heavy metal pollution of mercury (Hg). In addition to harming the environment and ecosystems in general, mercury greatly affects the level of morbidity and mortality in humans. Chronic effects arising from mercury poisoning was more frightening than the acute effects that occur [1-3].

Mercury that contaminates the environment, it can accumulate in the food which is the source for human consumption. Vegetables and fruits are grown in an environment that has been contaminated by mercury, or meat from livestock that eat grass and also contain mercury, when consumed by humans are very dangerous for human health. Health problems that arise depend on the amount of Hg levels that enter the body and accumulate in it. Symptoms that arise from the mildest of paresthesia to more severe symptoms of ataxia, dysarthria can even cause death. Babies born to mothers who consume mercury-containing foods (in the form of methyl mercury) when prenatal will experience abnormalities of cerebral palsy or mental retardation [4, 5].

The Bone River as one of the rivers in Gorontalo Province, located in two regions, Bone Bolango and Gorontalo, became the river with the greatest threat contaminated by mercury. The 2007 Gorontalo Provincial Environmental Research, Information and Technology Research Report states that mercury (Hg) levels in the Bone River are 0.022 mg / l (normally <0.002 mg / l). Research mercury content at the mouth of the Bone River has exceeded the allowed threshold of 0.01489 mg / l (at low tide at the bottom of the river).

The main cause by the existence of traditional gold mining as a producer of mercury waste discharged into the flow of the River Bone. This mining activity has existed even before Indonesia's independence, so that the feared toxicity process has occurred chronically to people using the Bone River water source should be a serious concern.

Therefore, this study aims to identify the health problems occurring in communities surrounding the Bone River related to mercury contamination and analyze the health problems that have occurred in terms of biomedical and community characteristics around the Bone River Gorontalo Province, and mapped spatially using a mapping system based GIS [6].

2. Material And Methods

2.1 Examination of Mercury

Based on data from the Gorontalo Provincial Environment and Research Agency of 2016, the existing gold mining activities in the Province of Gorontalo are indicated to have a negative impact on the quality of river water in Gorontalo Province.

The results of monitoring the status of Bone River water quality [7], ie on the upstream, middle, and downstream are on the status of black pollen.

2.2 Examination of Public Health Problems

a. Determination of research subjects

This study aims to assess the health effects associated with mercury on the people who live around the river Bone, Gorontalo province. The determination of the community to be the research sample is determined by the proximity of the residence with the Bone River.

Proximity is meant here is the people who live within a radius of 1 kilometer from the mouth of the river, so that all the houses that are within that radius will be the study population.

b. Data retrieval

Research data collected in some time at 5 points of sampling by using accidental sampling method, that is:

- The sample point I in Sukma Village, Botupingge District, Bone Bolango Regency, on May 19th, 2017, total sampleare 49 people.
- The sample point II in Panggulo Village, Botupingge District, Bone Bolango Regency, on May 20th, 2017, total sampleare 18 people.
- The sample point III in Dutohe Village, Kabila District, Bone Bolango Regency, on May 21st, 2017, total sampleare 24 people.
- The sample point IV in Lombongo Village, Suwawa District, Bone Bolango Regency, on June 15, 2017, total sampleare 19 people.
- The sample point V in Tulabolo Village, East Suwawa District, Bone Bolango Regency, on July 10th, 2017, total sampleare 28 people.

The total sample is 138 people.

Health data were taken using the standard "Protocols for Environmental and Health Assessment of Mercury Released by Artisanal and Small-Scale Gold Miners" issued by "the United Nations Industrial Development Organization (UNIDO)" modified adjusted to the examination requirements to be achieved.

2.3 Statistical Analysis and Mapping

Data processing uses a computerized statistical system and mapping using a GIS-based mapping system.

3. Results

3.1 General Data

Distribution of characteristic of research sample is viewed from general data that is gender, age and residence

based on sample point can be seen in table 1.

Table 1: Distribution of sample characteristics by sex, age and sample point

No	Characteristics		n	%
I	Sex			
	–	Male	39	28,3
	–	Female	99	71,7
II	Age			
	–	< 15 years	2	1,4
	–	16 – 30 years	18	13,0
	–	31 – 45 years	50	36,2
	–	46 – 60 years	46	33,3
	–	61 – 75 years	20	14,5
	–	> 75 years	2	1,4
	Mean	: 46,1 years		
III	Sample Point			
	–	The sample point I	49	35,5
	–	The sample point II	18	13,0
	–	The sample point III	24	17,4
	–	The sample point IV	19	13,8
	–	The sample point V	28	20,3

Source: Primary data, 2017

Characteristic of sample in this research indicate that most of sample is woman with percentage 71,7%. The average age of the sample was 46.1 years with the greatest number are in the age range 31-45 years (36.2%).

The highest sampling was obtained from point I of 49 people (35.5%) because in this area is quite densely populated. The distribution of the number of samples in the mapping based on the collection point can be seen in figure 1.

3.2 Correlation With Mercury

In sampling interviews, the question of mercury linkage includes three questions: (1) proximity to residence with mining areas, (2) work experience in mining areas, and (3) employment history as miners. The connection

with mining is shown in figure 2, where sample point V is the area closest to the mine located in Tulabolo Timur Village, East Suwawa District, Bone Bolango Regency. Frequency of association with mercury can be seen in table 2.

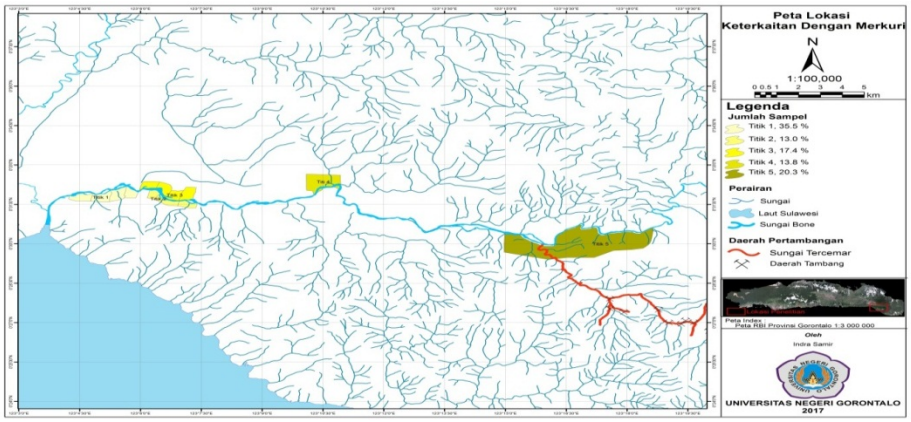

Figure 1: Mapping the distribution of the number of samples based on the collection point(https://drive.google.com/file/d/0B_H28R6ryXJ6b2MySjdCdTNNakE/view)

Table 2: Distribution of Relationship with Mercury

No	Relationship with Mercury	n	%
1	Yes	25	18,1
2	No	113	81,9
T O T A L		138	100

Source: Primary data, 2017

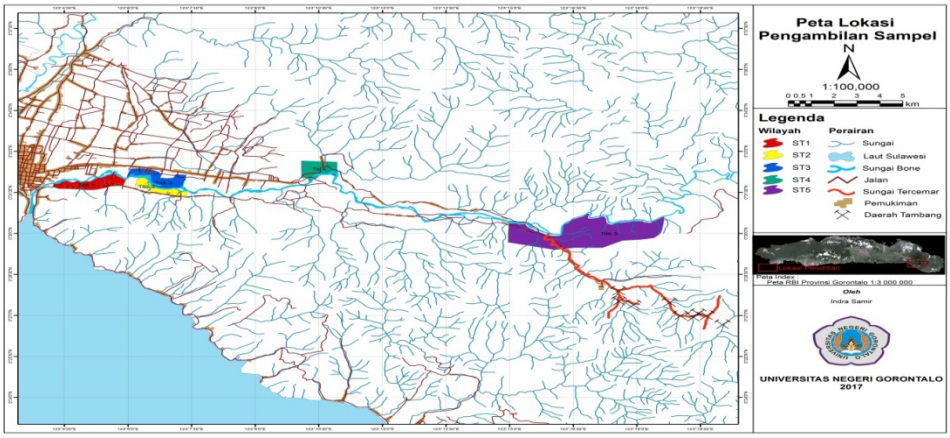

Figure 2: Mapping of sample point location based on proximity to mining area(https://drive.google.com/file/d/0B_H28R6ryXJ6WHZPN1BFbWtCVUE/view)

The presence or absence of mercury-linkage per sample research point, shown by graph 1.The graph explains that the closer to the mine (sample point V), the higher the mercury linkage (18 samples from 28 samples).

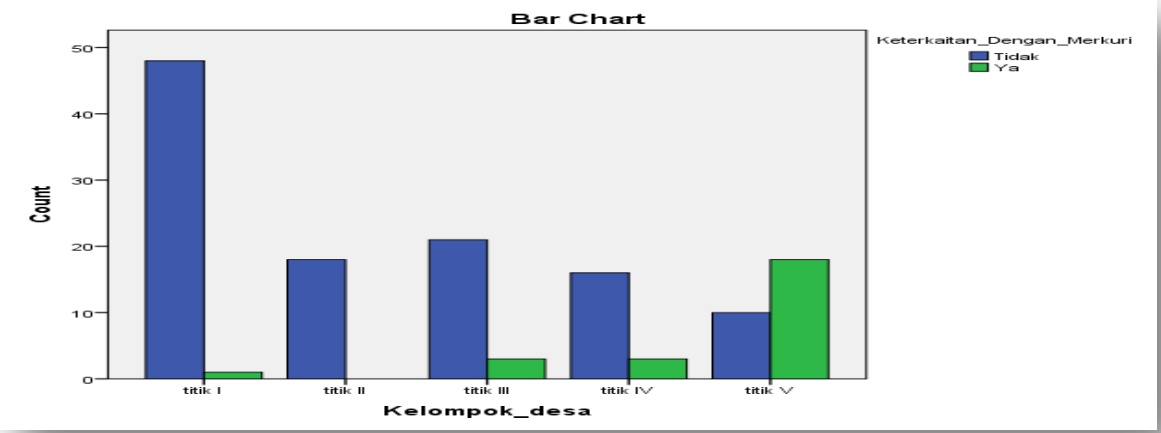

Figure 5: Distribution of mercury linkages at 5 sample points of the study

3.3 Anamnesis

Medical examination with anamnesis of symptoms of perceived health disturbance was done by giving 20 question to sample, but there are 2 very significant question in this research that is question about symptoms of headache and symptoms of numbness, cramping and pain (perioral disestesia or glove and stocking type) . The description of the distribution of headache complaints can be seen in table 3.

Table 3: Distribution of headache complaints

Criteria		Not frequent headaches	Frequent headaches	Total
Frequency				
–	**Quantity**	84	54	138
–	**Percentage**	60,9 %	39,1 %	100 %
Sample Point				
–	**The sample point I**	59,2 %	40,8 %	100 %
–	**The sample point II**	16,7 %	83,3 %	100 %
–	**The sample point III**	83,3 %	16,7 %	100 %
–	**The sample point IV**	73,7 %	26,3 %	100 %
–	**The sample point V**	64,3 %	35,7 %	100 %

Source: Primary data, 2017

Table 3 shows that the highest headache complaints are at sample point II and the lowest at sample point III, and the frequency of headache most of the sample did not feel the complaint.

Symptoms of numbness, cramps and pain (perioral disestesia or glove and stocking type) also provide results that are pretty much complained about. The distribution of these complaints can be seen in graph 2. It appears that in all sample points, these symptoms are symptoms that are often complained of by most samples.

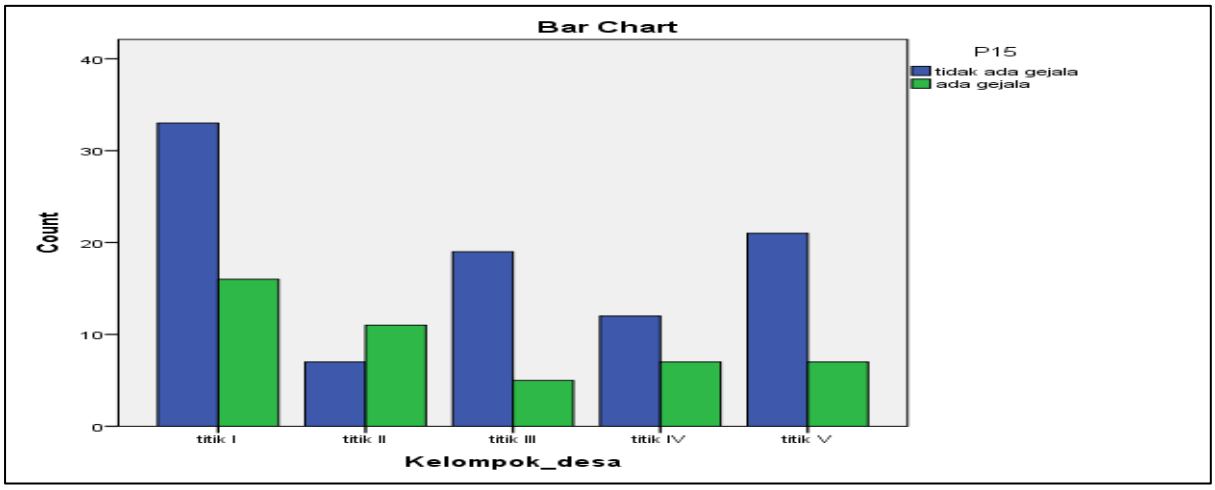

Figure 6: Distribution of atrophy, cramping and pain (perioral disesthesia or glove and stocking type) at 5 sample points (Source: Primary Data, 2017)

3.4 Clinical Neurological Asessment

Clinical Neurological Assessment focuses on the emergence of signs of changes in eye conditions, where the appearance of blue circles on the outside of the iris and presence of Kayser Fleischer signs, and the presence of symptoms of tremor in the test of finger to nose. Table 4 illustrates the presence or absence of eye disorders according to the sample point and table 5 shows the distribution of tremor symptoms based on the results of finger to nose test per sample point.

Table 4: Distribution of eye disorders according to the sample point

Sample Point	Disturbance (%)	No Disturbance (%)	Total
I	8,1%	91,8 %	100 %
II	27,8 %	72,2 %	100 %
III	8,3 %	91,7 %	100 %
IV	21,1 %	78,9 %	100 %
V	35,7 %	64,3%	100 %

Source: Primary data, 2017

The disturbed eye condition is most prevalent at the sample point V (35.7%) which is an area close enough to the mining area (Tulabolo Village). Mapping of eye conditions can be seen in figure 3. It is seen from Figure 3 that the disruption in the eye is higher in the sample point V area, and further away from the mining area, the less eye condition is reduced.

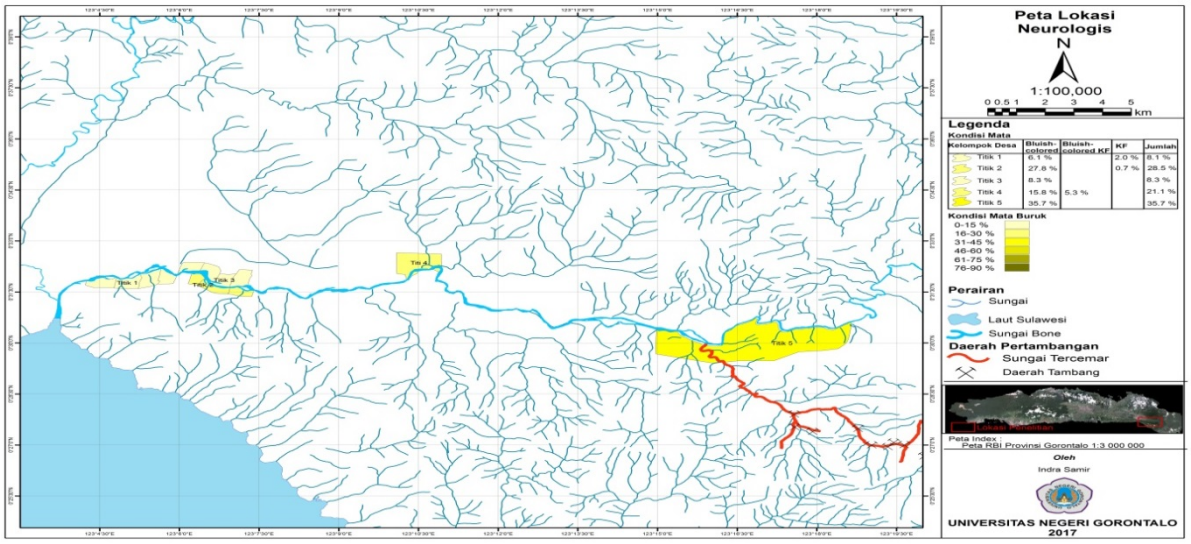

Figure 3: Mapping of eye conditions based on the sample point.(https://drive.google.com/file/d/0B_H28R6ryXJ6X0hrTlZ3WUY2NEE/view)

Table 5 shows that the symptoms of tremor shown by the sample through nasal examination were highest, there was a sample point IV (mild symptoms + weight = 15.8%) and sample point V (mild symptoms + weight = 28.6%).

Table 5: Distribution of samples based on the level of symptoms of tremor through the results of examination of the finger to nose test per sample point.

Sample Point	Tremor (%)			Total
	No symptom	Mild	Heavy	
I	87,8 %	12,2 %	0 %	100 %
II	72,2 %	11,1 %	16,7 %	100 %
III	100 %	0 %	0 %	100 %
IV	84,2 %	5,3 %	10,5 %	100 %
V	71,4 %	25,0 %	3,6 %	100 %
TOTAL	84,1 %	11,6 %	4,3 %	100 %

Source: Primary data, 2017

The sample point IV (Lombongo Village) and the sample point V (Tulabolo Village) are fairly close to the mining area. The mapping in figure 4 can illustrate the severity of the tremor symptoms per sample point. The older the purple color the higher the percentage of samples who experience symptoms of tremor based on neurological examination of the finger to nose test.

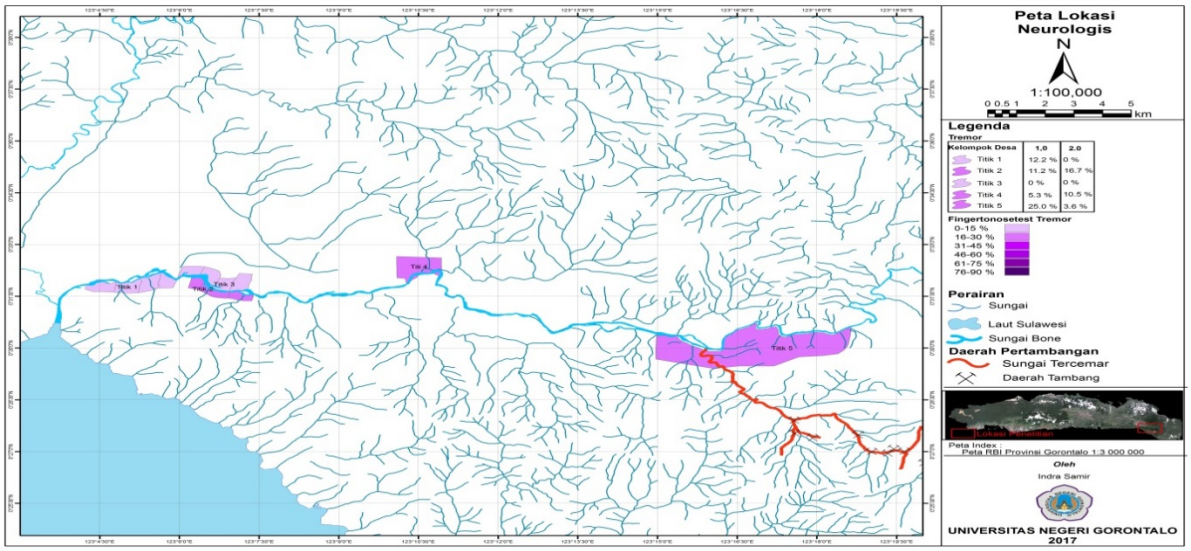

Figure 4: Mapping of symptoms of tremor symptoms per sample point.(https://drive.google.com/file/d/0B_H28R6ryXJ6WGh3cGZiYmFJWG8/view)

4. Discussion

Mercury is one of the chemical elements that are often used in the process of separation of gold with other metal elements follow. Mercury is a dangerous heavy metal, which in any small concentration can be toxic. Mercury and mercury compounds have very high toxicity, because they are highly reactive and are biologically active molecules, causing disruption of living things. The wider impact occurs when mercury has polluted the environment, because mercury will spread rapidly because of its very high mobility and can be concentrated through the food chain [8].

Humans as part of the food chain will not escape the impact of environmental pollution caused by mercury. The mercury pollution effect on human health is obtained because people consume food, even meat from livestock that consume plants that have been contaminated with mercury. The process of the occurrence of disease in humans is usually chronic, due to the length of the latent period from exposure to the onset of symptoms [9, 10].

The results of this study generally indicate that the health checks performed have shown symptoms of a disturbance caused by mercury. A very obvious health disorder is a neurological disorder which, as in this study, is a disorder of the eyes in the form of a blue circle on the iris and Kayser Fleischer sign, as well as the onset of tremors on the finger to nose test [11].

The effect of mercury toxicity on humans depends on the form of mercury composition, its entry into the body,

and its duration of development. An example is the mercury (HgCl2) more toxic than mercuro (HgCl). This is because the divalent form is more soluble than the monovalent form. In addition, the form of HgCl2 is also fast and easily absorbed so that its higher toxicity [2].

Organic forms such as methyl mercury, about 90% are absorbed by the intestinal wall, this is much larger than the inorganic form (HgCl2) which is only about 10%. However, this inorganic mercury form is less corrosive than the organic form. The organic form can also penetrate the blood barrier and placenta so it can cause teratogenic effects and neurological disorders [5]. The toxicity of mercury in humans is distinguished according to the form of Hg compounds, namely inorganic and organic. Hg inorganic poisoning has been known since the 18th and 19th centuries with thermic symptoms in adults. Symptoms of tremor have been known since the 18th century called "hatter's shakes" (hats shake), because at that time many workers in hat and wool factories suffer from these symptoms. Symptoms persist with tremors of the facial muscles, which then propagate to the fingers and hands. When the poisoning continues, tremors occur on the tongue, speaking haltingly, walking looks stiff, and loss of balance [2, 12, 14]. The research conducted by Arifin, Sakakibara and Sera in the journal geosciences (2015) states that the apparent neurological disorder of gold miners in Gorontalo Utara is generally a tremor (27%).

5. Conclusion

The conclusion that can be drawn from this study is that the major health disorders that appear associated with mercury pollution are neurological disorders, and tremor is the most common symptom. Further research is needed to conduct a deeper assessment of health problems in the community, particularly in relation to neurobehavior and neurocognition, both in adults and in children.

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