

Assessment of the current status, forecast of environmental quality changes in the Kon Tum Province, Vietnam and proposing measures to improve the effectiveness of environmental management in the studied area

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ABSTRACT

The Kon Tum province of Vietnam country has been industrialising and modernising with rapid pace and it has much contributed to the socio – economic development of not only the province itself but also to the country in general. However, accompanied with the development there have been emerged many environmental issues. In order to provide reliable and scientific data, information for policy makers and bussiness managers as well, the research related to assessing the current environmental quality in Kon Tum province, thenceforth proposing measures for efficient environmental management in the province has been implemented. The results gained from the research implementation show that: quality of water resources including ground water have been down; air environment of some places in the province has been contaminated compared with national technical regulations of Vietnam,The pollution and environmental quality reduction in the studied area have mainly been due to shortcomings in management in general and environmental management in particular. This research has also proposed solutions to improve efficiency of the environmental management in accordance with the planning of socio-economic development in the period of 2016-2020, driven by 2025 of the province.

Keyword: Kon Tum province, currenet environmental quality, solutions, efficiency

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I. INTRODUCTION

Over the past years, Kon Tum province – Vietnam country has accelerated the process of industrialization, modernization and urbanization at an ever-increasing rate, gross domestic products (GDP) ò the province have increased year by year: GDP increased from 9.2% in the period of 1996 – 2000; up to 14.5% in the period of 2006 - 2010. Many factories, companies and service business establishments have been built and developed. Along with the development, many issues related to the environment also arise: the quality of the air, water, soil and living environment in the province has deteriorated. However, there has not yet been any research related to assessment of environmental status and the changes in environmental quality in Kon Tum province. Due to the lack of information, some development policies and orientation of state managers and business managers as well are not appropriate and friendly to the environmmt

In order to protect the environment, but not to slow down the economic development of the province, it is necessary to have a systematic, scientific study of the status of environmental quality and forecast of environmental quality changes in Kon Tum province up to 2020, hence proposing environmental management measures suitable to the development of the province is very necessary and this is also the main reason for the research “Assessment of the current status, forecast of environmental quality changes in Kon Tum Province, Vietnam and proposing measures to improve the effectiveness of environmental management in the studied area” has been implemented. The results obtained during the project implementation will be reliable data for policy makers, environmental managers as well as enterprises in the province to orient and develop the economic development policies and plans.

II. RESEARCH CONTENTS AND METHOD

2.1. Research contents

In order to achieve the objectives of the research, such contents as: general study of the Kon Tum province – Vietnam; servey and assesment of current status of quality of environmental components, including air, surface water, groundwater and wastewater; evaluation and forecast of the change of environmental quality, the evalution has been conducted based on environmental data recorded from 2009, the data collected and analysed in the process of the research implementation, the forecast of the change of environmental quality in the studied

region has been based on research data gained and the orientation for socio-economic development of the province in the period of 2016-2020; and developing measures for improving the effectiveness of environmental management in the Kon Tum province – Vietnam.

2.2. Materials and methods

In the research implementation, there have been used a number of equipments such as Garmin GPS (used to determine co-ordinates), car, motorbikes, recorders, water cans, baskets, questionnaires and so on. The methods which have been applied in conducting the research are: Documentation and data collection, the data collection has been implemented by surveys through face – to – face contact or filling in given questionnaire, there are 05 air sites with parameters such as noise, TSP, CO, SO₂, NO₂, H₂S, NH₃, HC measured and analysed, 03 groundwater samples collected and such parameters as temperature, pH, hardness, NH₄⁺-N, SO₄²⁻, Fe, Cl have been analysed, 02 wastewater samples collected in two locations and parameters analysed are pH, TSS, COD, BOD₅²⁰, NH₄⁺-N, PO₄³⁻-P, Fe total, and 02 soil samples taken at 02 locations have been analysed parameters humidity, pH (H₂O), pH (KCl), EC; Comparative and assessment method have been used in assessing the environmental quality of the area in the past and present; Forecasting methods have been used in the research in order to estimate environmental pollution loads as well as their concentration in the environment, since then, based on socio - economic development plan/strategies of the province, assessing change trends (increase or reduction) and impact level of those pollutants on the environment. The Euler Model which is expressed by following equation:

$$N_t = N_0 * e^{kt}$$

Where: N_t - population at the time forecasted; N₀ - population at the present time; k - population growth rate; and t - difference between present and estimated times - year.

III. RESULTS AND DISCUSSION.

3.1 General description of the studied area

The Kon Tum province, which is located in the extreme north of the Central Highlands - Vietnam, is strategically important region in terms of economy, politics, society and national defense in the Central Highlands in particular and the whole country in general. Total area of the province is 969,046 ha. It is the tropical monsoon climate zone. The annual average temperature fluctuates between 22 – 23⁰C, the amplitude fluctuates in day 8 – 9⁰C. The average annual humidity ranges from 78 to 87%. Monthly humidity is highest in August - September (about 90%), lowest in March (about 66%). Surface water are mainly rivers and streams originating from the north and northeast of Kon Tum province, underground water sources of the Kon Tum have high potential and industrial reserves of 100 thousand m³/day, especially at depths of 60-300 m with relatively large reserves.

Practically, economic growth rate (GDP) of the region, on average, reached 15.0% in the period 2011-2015 and according to prediction, the rate would be reached about 14.5% in the period 2016 - 2020. In which, the GDP of industry and construction have increased about 20.0% in the period of 2011-2015 and in prediction, it would increase 17.5% in the period 2016-2020. The direction of socio-economic development of the Kon Tum province would be towards sustainable industrialization and modernization: exploiting the potentials and advantages of the province; catching opportunities in the process of international integration; and promoting economic growth together environmental protection.

3.2. The current status of environmental quality and forecast of it's change in the studied area.

During the implementation of the research, a number of positions which are representative of the studied area have been chosen to measure or take samples for analysing characteristics. The samples that have been measured or taken in the process of the research implementation include: 05 air samples; 04 samples of surface water; 03 ground water samples; 02 wastewater samples; and 02 soil water. Data related to environmental quality of some environmental components in the studied area, which had been monitored in the period of 2009 – 2013, have been collected in order to assess and forecast the change of the environmental quality.

3.2.1. The current status of environmental quality in the Kon Tum province

3.2.1.1. Air quality.

In September 2015, the research measured and collected air samples at 05 points for analyzing air environment. The points which have been chosen are representative of different types of the air environment such as active transportation, landfills, urban and industrial areas. The taken samples were sent to Center for monitoring and analysing of the Kon Tum province for analysing environmental parameters and the results are presented in Table 3.1 below.

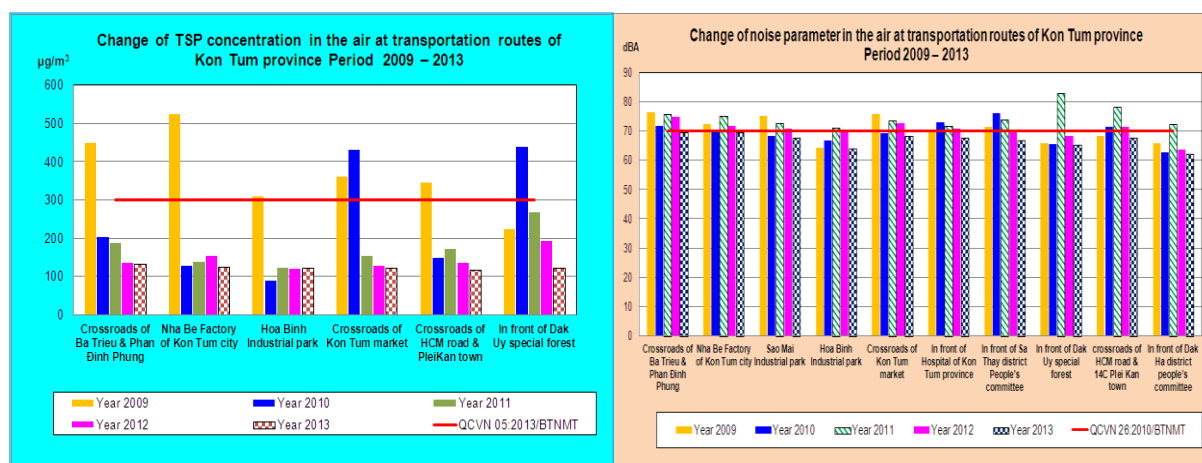
Table 3.1: Results measured and analysed of air environmental parameters

No.	Parameters	Unit	Results					Limits allowed
			K ₁	K ₂	K ₃	K ₄	K ₅	
1	Temperature	⁰ C	30	29	30	29	31,0	-
2	Humidity	%	72	67	62	61	52	-
3	Nose: L _{Aeq}	dBA	62	65	72,0	50,4	60,2	70 ⁽³⁾
	Nose: L _{Amax}		68,1	72,2	79,2	60,2	65,0	70 ⁽³⁾
4	TSP	µg/m ³	143	155	151	133	143	300 ⁽¹⁾
5	SO ₂	µg/m ³	24	22	25	27	29	350 ⁽¹⁾
6	NO ₂	µg/m ³	29	28	30	30	36	200 ⁽¹⁾
7	H ₂ S	µg/m ³	33,2	36,8	32,1	32,0	31,5	42 ⁽²⁾
8	CO	µg/m ³	1154	1021	1291	1275	1202	30.000 ⁽¹⁾
9	NH ₃	µg/m ³	132	150	144	122	142	200 ⁽²⁾
10	HC	µg/m ³	380	276	250	294	345	5000 ⁽²⁾

Notes: (-): No regulations; K₁ Sao Mai place, Kon Tum city; K₂: Area Solid Waste Complex Glory - Kon

Tum city; K₃: Cluster villages brick production Vinh Quang - Vinh Quang ward - Kon Tum city .; K₄: center for border trade and Bo Y border control; K₅: ecological cum resort center- Kon Plong district; (1) - National Technical Regulation on ambient air quality: 05:2013/Monre-VN; (2) - National Technical Regulation on certain hazardous substances in the ambient air: 06:2009/Monre - VN; (3) - National Technical Regulations on noise: 26: 2010/Monre - VN

According to Duong Thi Hong Luan (2016), in the period of 2009 – 2013, the Center for monitoring and analysing of Kon Tum province had monitored 16 points distributed in urban areas where population density is quite high, the air environmental parameters such as TPS and noise in that points have been monitored and the data collectd by the Center are presented Fig 3.1 below.



Source: Duong Thi Hong Luan (2016)

Figure 4.1: TSP and noise levels in the air at 16 monitoring sites

Notes:

- QCVN 05/2013/BTNMT = National Technical Regulation on ambient air quality: 05:2013/Monre-VN.
- QCVN 26/2010/BTNMT = National Technical Regulations on noise: 26: 2010/Monre - VN

The data presented in the table 3.1 and figure 3.1 show that: in general, the atmosphere in the province has not been contaminated by toxic gases and concentrations of air pollutants in the Kon Tum province had been stably decreased over the monitoring years; concentration of TPS in the atmosphere in year of 2013 and 2015 has been lower compared with current regulations of Vietnam although it had been higher the limits allowed, especially in 2009; and there is phenomenon of noise levels which is exceeded level compared with the current regulation.

3.2.1.2. Water environmental quality

a) Surface water.

There had 03 points representative of the studied areas been chosen to take surface water samples in order to analyse levels of pollution substances existing in the water. The collection and analysis of the samples were

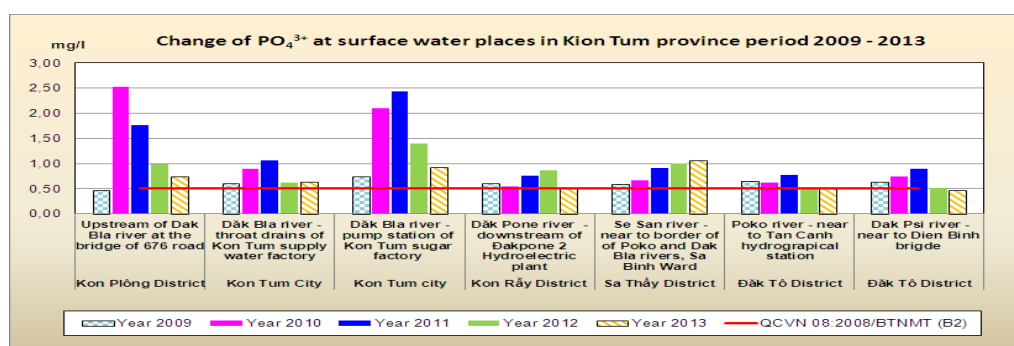
conducted in September, 2015, the analysed results then are compare with the results of the data monitored in the period 2009 – 2013 by the Center for environmental monitoring and analysing of the Kon Tum province. Outcomes gained from the analysing the samples collected in Septamner, 2015, have been shown in table 3. 2

Table 3. 2. Results of measurement and analysis of surface water quality

No.	Parameters	Units	Results analysed			Reg. 08:2008/Monre - VN			
			S _{PC1}	S _{PC2}	S _{ST3}	A1	A2	B1	B2
1	pH	-	6,52	6,82	7,0	6-8,5	6-8,5	5,5-9	5,5-9
2	TSS	mg/l	16,60	25,82	9,2	20	30	50	100
3	DO	mg/l	6,80	6,70	8,92	≥ 6	≥ 5	≥ 4	≥ 2
4	COD	mg/l	13,8	14,6	34	10	15	30	50
5	BOD ₅ ²⁰	mg/l	5,40	8,9	13,6	4	6	15	25
6	Fe	mg/l	0,38	0,40	0,44	0,5	1,0	1,5	2,0
7	PO ₄ ³⁻ -P	mg/l	0,14	0,13	0,11	0,1	0,2	0,3	0,5

Notes: (-): No regulations; SPc1: The Po Ko river watershed, Dak Pet commune, Dak Glei District; SPC2: Throat drains of the town water supply plant Dak Dak stream Kan, Dak To district; Sst3: The Se San joins the border near Vietnam - Cambodia - Sa Thay River; Reg. 08: 2008/Monre-VN - National Technical Regulation on Surface Water Quality; A1, A2, B1 and B2 – Grading of surface water resource for purpose of use.

The change of PO₄³⁺ of surface water in 7 points which have been similar with, in position or in terms of characteristic, the 03 points presented in table 3.2 above have recorded by the Center for environmental monitoring and analysing of the Kon Tum provinces. The data of PO₄³⁺ of surface water in 7 points that have been monitored in the period of 2009 – 2013 are presented in figure 3.2 below.



Source: Duong Thi Hong Luan (2016)

Figure 3.2: The PO₄³⁻ in surface water monitoring sites between 2009 and 2013

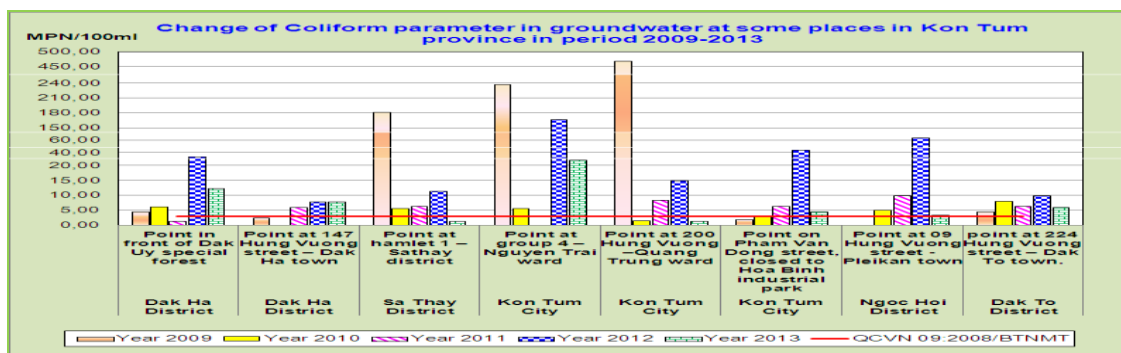
Notes: QCVN 08:2008/BTNMT (B2) = Re. 08: 2008/Monre-VN: National Technical Regulation on Surface Water Quality: 08:2008/Monre-VN; B2 – For purpose of use: waterways or other purposes which do not require high quality.

From the results presented in the table 3.2 above, it could be assessed that most of the parameters are within limits compared with Re. 08:2008/Monre – VN, grading A2, B1 and B2. However, parameters such as COD, BOD anf PO₄³⁺ have exceeded limits for pupose of use for domestic water supply. The data mentioned in fig 3.2 above also show that concentration of PO₄³⁻ in the region was higher at most positions monitored.

Based on the data gained form the research implementaion and monitoring in the past it could be conclude that the high level of some parameters of surface water in the research region are due to lack of planning in development of industry, agriculture and shorcomings in environmental management as well.

b) Groundwater

According to Duong Thi Hong Luan (2015), microbial contamination of groundwater in the research region has also been monitored in the past by the Center for environmental monitoring and analysing of the Kon Tum province. The change of level of microbial contamination in 08 positions of the Kon Tum province in the period of 2009 – 2013, are shown in figure 3.3 below.



Source: Duong Thi Hong Luan (2016)

Figure 3.3: The level of microbial contamination at the monitoring sites in the areas.

Notes: QCVN 09:2008/BTNMT = National Technical Regulation on Groundwater Quality: 9:2009/Monre-VN. As can be seen from figure 3.3 above, most wells in the cities, towns or in high density of population have been contaminated by microbial, especially in 2009 it was very high compared with the national technical regulation. For the purpose of assessing current status of groundwater and its change, in September 2015, the research has taken 03 groundwater samples in three wells in three different positions (symbolised G_{KT1} , G_{KT2} and G_{KT3}). The results of analysing the samples are presented in table 3.3 below.

Table 3.3: Results of analysing groundwater quality

No.	Parameters	Units	Results analysed			Reg.09:2008/MONRE-VN
			G_{KT1}	G_{KT2}	G_{KT3}	
1	Nhiệt độ	$^{\circ}C$	28,0	27,8	27,7	-
2	pH	-	6,72	6,42	6,32	5,5 – 8,5
3	Độ cứng	mg/l	83,4	83	82	500
4	NH_4^+-N	mg/l	0,180	0,09	0,06	0,1
5	SO_4^{2-}	mg/l	3,0	4,2	4,8	400
6	Fe	mg/l	1,2	0,82	0,22	5
7	Cl^-	mg/l	8,32	8,62	8,80	250

Notes: (-): No regulations; G_{KT1} : Regional Landfill Quang Vinh City. Kon Tum; G_{KT2} : Well in Economic Zone Bo Y international border gate located at the first, Bo Y commune, Ngoc Hoi district; G_{KT3} : Well houses Dak Tan township, Kon Ray district; Reg. 09:2008/Monre-VN: National Technical Regulation on groundwater quality

Among 07 parameters of 03 groundwater samples analysed and presented in the table 3.3, there is only concentration of NH_4^+-N in 01 well symbolled G_{KT1} exceeded compared with the regulation. The contamination of that well could be explained due to the leakage of domestic water waste from household activities.

c) Wastewater

In the process of research implementation there have 02 samples representative of urban and industrial wastewater collected and analysed. The time of collection of the sample has been in September 2015 and the results gained from analysing the samples are presented in table 3.4 below.

Table 3.4: Results of analysis of wastewater characteristics

No.	Parameters	Units	Results analysed		Limits
			NT_{DT1}	NT_{HB1}	
1	pH	-	5,72	6,79	5,5 – 9 ⁽¹⁾⁽²⁾
2	TSS	mg/l	194	19,2	100 ⁽¹⁾⁽²⁾
3	COD	mg/l	195	18,10	150 ⁽²⁾
4	BOD_5^{20}	mg/l	98,2	7,11	50 ⁽¹⁾⁽²⁾
5	NH_4^+-N	mg/l	12,0	0,50	10 ⁽¹⁾⁽²⁾
6	$PO_4^{3-}-P$	mg/l	3,80	2,4	10 ⁽¹⁾
7	Fe tổng	mg/l	0,6	0,71	5 ⁽²⁾

Notes: NT_{DT1} : wastewater discharging East Kon Tum city through channel N1; NT_{HB1} : The wastewater treatment system of industrial parks Hoa Binh; and (1) National Technical Regulation on Domestic Wastewater – 14:2008/Monre - VN; (2)- National Technical Regulation on Industrial Wastewater- 40:2011/Monre - VN

The data gaining from research that have illustrated in the table 3.4 above show that wastewater after treatment in the channel of East Kon Tum city has concentration of COD, TSS, BOD, $\text{NH}_4^+\text{-N}$ higher than the regulation and wastewater treatment of industrial parks have done quite well and wastewater after its treatment meet the regulation.

3.2.2. General assessment of the current environmental quality and environmental management in the area

Based on the data, informations gained from the research implementation process in conjunction with the data monitored in the past, it could generally assess that:

- Current environmental quality in the research area presently is quite good and most of environmental parameters of air and water, including surfacewater and groundwater, are within the limits allows according to environmental regulations of Vietnam. There have been some environmental parameters in the area which exceed environmental regulation but the excess level of that is not so high.
- The areas in which there is high population density or concentrated factories or services have higher level of pollutions compared with others.
- The pollution levels in the research region tend to decrease steadily over the years.
- The environmental management system in the research region have quite actively operated, however efficiency of the works is not high due to many reasons: responsibility assigned is not clear and overlapped; lack of equipments; the number of staff is small, not meet the required quantity; shortage of properly – educated staff; and awareness related to environmental protection of community and enterprise hosts is low.
- Finance is also one of the reasons that cause the shortcomings in environmental protection.

3.2.3. Forecasting environmental quality changes in the Kon Tum province by the year of 2020.

3.2.3.1. Environmental air quality

Based on data of population of the Kon Tum province in 2014 (487.273 people), number of motobikes in each household (02 motorcycles), the province's plan of economic-society development and Euler model, by the year of 2020, in Kon Tum province there will be about 591.594 people, around 23.637 automobiles of all kind (where: 12.691 trucks/lorries, 10.946 four-wheeled vehicles), 06 industrial parks with total land area approximately 2.491ha. Therefore, loads of air pollutants released into the air environment in the province would be very much, detail of pollutant loads is expressed in following tables.

Table 3.5: Pollution loads due to transportation by year of 2020.

Kind and engine capacity of vehicles	Emission load(kg/day)				
	TSP	SO ₂	NO _x	CO	HC
Motorcycle 50cc	-	7,1	283,97	18.635	2.840
Automobile < 2.000cc	162,45	37,78	4.159	36.778	5.223
Automobile > 2.000cc	62	16,19	2.195	13.738	1.950
Light weigh truck < 3,5 ton (diesel engine)	1.655	94,58	5.675	8.512	1.230
Total	1879,5	155,7	12.312,9	77.663	11.243

Table 3.6: Kinds and loads of contaminants released in atmosphere of the industrial parks in Kon Tum province by year of 2020.

Industrial parks	Area (ha)	Emission loads (ton/ha/year)			
		Dust	SO ₂	NO _x	Sum.
Hoa Binh	130	585	1.560	221	2.366
Sao Mai	150	675	1.800	255	2.730
Dak To	150	675	1.800	255	2.730
North Bo Y	217	976,5	2.604	368,9	3.949,4
Con. Indus. Bo Y	1.566	7.047	18.792	2.662,2	28.501,2
South BoY	278	1.251	3.336	472,8	5.059,8
Total	2.491	11.209,5	29.892	4.234,9	45.336,4

3.2.3.2: Water environment

By the year of 2020, population of the Kon Tum province would be up to 591.594 people and water consumption would reach to 70.991m³/per day, domestic wastewater may be about 56.793m³/per day. According to data on operation of the industrial parks and clusters in recent years in the province would be

estimated about 62.275m³/day in 2020, details of wastewater, each hectare of industrial park area or industrial cluster operated discharge on average around 25m³/day. Therefore, amount of wastewater from the industrial parks and cluster quantity would be about 62.275 m³/day with about 10.960 kg/day of TSS; 15.880 kg/day of COD; 8.469 kg/day of BOD.

Regarding to medical wastewater, based on population data calculated above and number of beds planned for Kon Tum province, there would be 2,739 patient – beds in 2020 with 684.75m³/day of medical wastewater.

3.3. Measures proposing to improve efficiency of the environmental management in the studied area

As assessed and forecasted which have been mentioned above, the environmental management system in the Kon Tum province have got many shortcomings which are the barriers for efficient activity regarding environmental protection of the system. Therefore, in order to improve the capacity of the system in terms of environmental protection in the studied region, it should be applied such measures as:

- Financial investment for the environmental protection activity: Increasing investment and expenditures for environmental monitoring activities annually and enhancing capacity of environmental analysis activities towards modernization, synchronization with national & international environment monitoring systems; Mobilising capitals from such sources as businesses, organizations and individuals in country and abroad, ODA, FDI ... to invest with environmental monitoring network system of Kon Tum province.
- Steadily renewing and perfecting the existed environmental protection system in the studied region by: clear assigning responsibility for units in the system, avoiding responsible overlapping; enhancing capacity in environmental protection of the staff through training, educating and updating informations regarding environmental field as well.
- Changing or improving policies, institutions, legal documents related to environmental management: Operation of the environmental management system would be more effective if the following measures to be taken: Reviewing and proposing changes of some in force documents legal regulations, economic and technical norms related to monitoring; Reviewing, building and supplementing (where is needed) incentive scheme for staff working in environmental protection units; Occupational standardisation for staff working in environmental units that are usually in touch with hazardous environment (taking and analysing wastewater samples, soil or air samples in the factories which consume much of raw materials having high toxicity, etc)
- Enhancing the works in terms of environmental communication and education in not only community but also business, production units and schools of all levels as well.

IV. CONCLUSION.

Based on the results obtained from the research process, it could be concluded that:

- Despite of current environmental quality in Kon Tum province – Vietnam is still quite good and the pollution levels in the research region tend to decrease steadily over the years. However, along with socio – economic development, environmental quality in the region has been decreased, some environmental parameters exceed current environmental regulations although the excess level of that is not so high.
- In the areas where is high population density or concentrated factories or services level of contaminants is higher compared with others. Along with development orientation of the province, in the near future, there could forecast that the loads of contaminants discharging and releasing in to the environment would increase.
- The environmental management system of the Kon Tum province has quite actively operated, however efficiency of the works is not high due to many reasons, including administration, managerial methods and finance as well.
- Applying such measures as financial investment in environmental protection activities, including proper education for the staff in terms of environment; improvement in administration towards avoiding overlaps and clear responsibility assign in environmental management; and enhancing environmental communication and education for community and enterprises would be more efficient.

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