

FCh_15

**CHALLENGES OF SLUDGE MANAGEMENT IN DEVELOPING COUNTRIES
TOWARDS SUSTAINABLE ENVIRONMENT WITH PARTICULAR REFERENCE
TO INDONESIAN CONDITION**M. A. Fulazzaky¹, A. H. Gany²¹Department of Water Resources and Environmental Engineering, Faculty of Civil and Environmental Engineering, University of Tun Hussein Onn Malaysia, Johor, Malaysia²Indonesian Ministry of Public Works, Jalan Pattimura No. 20 Jakarta 12110Email: fulazzaky@yahoo.com**ABSTRACT**

Most of the developing countries particularly Indonesia will be facing the dilemmatic problems of sludge pressure in next decades due to increasing the legal and illegal loggings as well as the land and water demands resulting from the population growth, improved standard of people living and urbanization as well as economic and industrial developments. Consequence, there will be facing also the challenges of sludge management due to increasing the quantity and extend of sludge affected living environment coming from several potential sources such as the activated sludge, fecal sludge and solid waste as well as the erosion and sedimentation, and it must be also accompanying the request of specific procedure, method and technology for handling each of their problems.

The government of Republic Indonesia has been enacted the strategy and policy as well as the programme and activity related to sludge management, such as the Water Resources Law No. 7/2004 and the National Movement for Forest and Land Rehabilitation as well as the National Movement for Water Resources Management Partnership. The inter-ministerial coordination efforts related to realize the programmes of reducing erosion and sedimentation, spatial planning arrangement, water quality management and pollution control as well as the programme for handling the water resources conservation have been initiated for 4 river basins in West Java i.e., the Ciliwung, Citarum, Cimanuk and Citanduy river basins. Despite, not cover for entire the city, the several centralized domestic wastewater treatment plant such as in Medan, Jakarta, Bandung, Cirebon, Yogyakarta and Surabaya as well as the industrial wastewater treatment plant cross the country have been also promoted in Indonesia.

Role sharing of each institution related to sludge management at the local and central government levels, NGO's and public participation as well as the contribution of private sector and sharing among the related sectors must be clearly defined. Some local autonomous request such as the implementation of Zero ΔQ , Zero ΔE and Zero ΔP policies as well as solid waste, fecal sludge and activated sludge managements must be taking over by the municipal or district governments.

The river basin upstream-downstream interaction mechanism by involving the stakeholder participation gives a perspective programme for handling the erosion and sedimentation problems and could be promoted in the developing countries for the years to come. And the utilization of sludge for fertilizer and other purposes needs to be scrutinized the right procedure and technology both for monitoring the amount of mineral containing the sludge and the adaptation of destined land use for sludge dumping.

Keyword: *sludge management, environmental sustainability, developing country*

INTRODUCTION

Sludge management is currently and will remain a dilemmatic issue for developing countries including Indonesia in the years to come, despite that such a challenging problem has yet become the major development priority of the country. Meanwhile, the amount of sludge products resulted from human activities are continuously accelerating from year to year due to the hardly controllable pressure of accelerating population on one side and economic growth on the other. As the result the negative impacts to environment particularly due to solid and liquid wastes as well as their accompanied maladies are continuously jeopardizing the human health as well as environment.

The several efforts have been done by the Government of Indonesia but it is not significant for reducing the accumulated impact producing the sludge sowed everywhere in the country from year to year, so that the new right policies and strategies as well as the programmes and activities by involving the participation of stakeholders are urgently required to be implementing for the next years to come.

Given such a dilemmatic problems of overdosed sludge in environment, it is unavoidable to put special scrutiny in the first place to launch a sort of national movement campaign particularly for developing sense of crises of the entire community from the grassroots up to the top decision making executives and political leaders, and followed by systematic implementation of sustainable sludge and environmentally friendly development and management technicalities.

POTENTIAL SOURCES AND PROBLEMS OF SLUDGE MANAGEMENT

Several potential sources of sludge coming from different activities such as soil erosion and sedimentation; land and forest degradation, domestic and industrial wastewater, solid waste disposal, night soil, and sludge of wastewater treatment plant. However, the main source of sludge of the country is due to uncontrollable soil erosion which, eventually entailed with huge amount of sludge accumulation to hamper public infrastructures (Figure 1). For example, the upper Citarum river basin area in West Java alone, with an average capacity of 92.3 m³/s has been reportedly brought about at least 1.05 million ton per year of suspended sediment during the period 1981 to 1982 and reportedly increased to 1.47 million ton per year in the year 2004, or about 40% increase within a period of 20 years [8].

The extension of river basin degradation has been reported increasing the year to year mainly due to uncontrollable illegal logging and land use conversion, the area of critical forest and land scattered cross the country was noted increase from 13 millions ha in the year 1992 to 21 millions ha in the year 2001 and yield up to 45 millions ha in the year 2005. The impact of forest and land degradations provoking the loss of the several spring water and also reporting that the several reservoir and lake are continuously fulfilled by the sludge, such as the Sengguruh and Saguling reservoirs as well as the Limboto and Rawa Pening lakes [10].

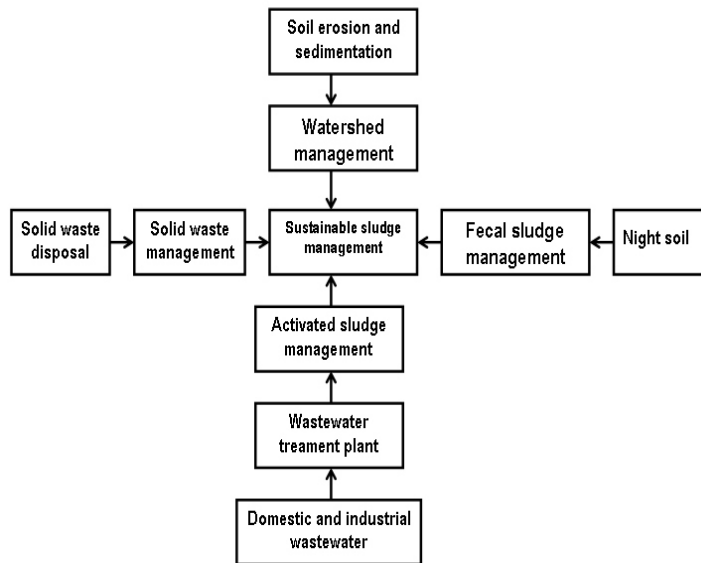


Figure 1: Components of sustainable sludge management.

Naturally, water as a recipient riches of a mixture medium so that the environment of suspended sediment comprise of organic pollutants, oxygen, microorganisms, and indispensable elements associating the domestic and/or industrial wastewater, which rejected into open surface water. Under autrophication process, a part of pollutants serves the synthesis of biomass henceforth settled down as activated sludge in the bottom of rivers, lakes, and reservoirs and the rest provide for growth energetic demands and for maintenance of microorganism cells [1]. For illustration, in the year 1995 the total estimated organic pollution loads brought to the Suguling reservoir in the Citarum River is about 143 ton of BOD per day [2] not including the substantial amount of solid wastes of the big cities in the vicinity areas.

In several reservoirs such as the Jatiluhur, Cirata and Saguling was reported the fish killed in the floating net (local name: keramba) often occurs, the accident usually founded between November and January for each year. In the year 1991, fish killed in the Saguling had reached the amount of 405.5 tons and in January 1995 about 3,000 tons of fish were killed in the Jatiluhur reservoir [9]. The hazardous matters dissolved in reservoir's water and fermentation of sludge in the bottom of reservoir may be appeared as the reasons of this phenomenon due to deteriorated water quality caused by uncontrollable pollution loads entry to the Citarum river and also the accumulation of waste coming from fish feed and its excrete as well as suspended matters settled down onto the bottom of reservoirs, while for certain time the polluted water layer is uplifted everywhere entire the reservoir by water's density current.

The case of sedimentation the Sengguruh reservoir which covering the catchment area of 1,659 km² located in the upper Brantas river system in East Java province – as one of developed river system in Indonesia, gives a good illustration for the sludge management problems coming from soil erosion. With the total initial storage of 21.5 millions m³ the reservoir designed for trapping the sediment of the Sutami reservoir which located in the downstream and producing the energy of the power generation of 29,000 kW. The designed live time of reservoir is for 20 years but with the erosion rate of 0.58 mm per year due to uncontrollable land and forest degradations accumulating the legal and illegal logging as well as the land use conversion and bed destined land preparation for agriculture purpose, after 12 years from 1988 to 2000 the reservoir was fulfilled by the sediment (see Figure 2). The volume of average annual sediment reported during the period of 15 years, 1988 – 2003, is 1.44 millions m³ per year and with specific erosion rate of 869.81 m³ per km² per year, and dredging the sediment – as the effort for handling the sludge problem in the reservoir – during the period of 9 years, 1995 – 2004, transferred the amount of 1,795,828 m³ and actually the effective storage capacity of the Sengguruh reservoir is 2.5 millions m³ [7].



Figure 2: Sedimentation of the Sengguruh reservoir in East Java, 2000

The solid waste also contributes to increasing the sludge in environment, coming from both the decay of solid waste and the resultant of soil destruction owing to abundant mineral elements accompanying the leached solid waste [4]. Huge garbage production from the cities needs a good practice of solid waste management in Indonesia. For illustration, the 3 biggest cities Jakarta, Surabaya and Bandung product respectively environ 25 thousands, 9 thousands and 6,5 thousands m³ of garbage per day in the year 2002, with the percentages of capability handled garbage for each city are respectively environ 96, 77 and 70 % [6].

Another potential source of sludge is associated with latrines or toilets, refers to as night-soil, having collected during the night in the past [3]. The problems with fecal sludge management is that the collected night-soil is discharged untreated – especially due to excessive distance of disposal sites, traffic congestion, and lack of suitable night-soil treatment options.

Similarly, the wastewater treatment plant that produces sludge also having had poor treatment, at the same time, the activated sludge management purged from a wastewater treatment plant has yet become an urgent priority in Indonesia. The latter problem is due to a limited knowledge, technology and facilities for biotechnology application, as well as the effectiveness of the related regulatory instruments.

PROGRAMMES AND ACTIVITIES RELATED TO SLUDGE MANAGEMENT

During the last few years, the Government of Indonesia put special effort for integrated water resources management as a mean of comprehensive application of sustainable management of water related sludge transportation, through the newly enacted Water Resources Law No. 7/2004. For reducing the amount of sludge due to erosion, the new law prescribes inter-ministerial coordination involving the Ministry of Forestry, Ministry of Agriculture, State Ministry of Environment as well as the Ministry of Public Works, and other related institutions.

The first programme as a pilot inter-ministerial project has been selected for 4 river basins in West Java i.e., the Ciliwung river basin is focused for handling the erosion and sedimentation as well as flood problems affected the Jakarta city in down stream area related to the spatial planning improvement of the special region Bogor-Puncak-Cianjur (Bopunjur); the Citarum river basin is selected by considering the water quality and pollution control related to the water resources conservation programmes for protecting the 3 cascade reservoirs: Saguling, Cirata and Jatiluhur as located in the Citarum river system as the principal water sources for hydropower, industry, irrigation and aquaculture as well as domestic purposes in West Java and DKI Jakarta provinces; the Cimanuk river basin is destined for protecting the Jatigede reservoir candidate from sedimentation in order for optimizing the reservoir life time in the future; and the Citanduy river basin is initiated for reducing the erosion coming from the upstream and withdrawing the sedimentation into the Sagara Anakan lagoon in the downstream area.

In the year 2003, the Government of Republic Indonesia – under coordination of the Coordinating Ministry of Public Affairs (Menko Kesra) – has been launched the National Movement for Forest and Land Rehabilitation, the programme focused for reducing the frequency and extending of flood and drought as well as erosion and sedimentation, with the target area of 3 millions ha and the period of implementation during 5 years. And in the year 2005, based on the courage for solving together the water, land and forestry problems the Government of Indonesia has been also launched the National Movement for Water Resources Management Partnership focused for integrating the programmes and actions among the related institutions and involving the stakeholders for realizing the required programmes.

The centralized domestic wastewater treatment plant has been developed for several cities in the country i.e., Balikpapan, Banjarmasin, Bandung, Cirebon, Denpasar, Jakarta, Medan, Prapat, Surakarta, Tangerang, and Yogyakarta but the capacity of plant is not cover for household of entire city. The applied technology is only focused to reduce the carbonaceous pollutants wherewith don't given a high respected to the nitrogenous and phosphorous pollutants removal. And factually, the majority of people living in the concentrated area of city used the individual septic tanks which only cover for the black wastewater only and the grey wastewater is directly ejected to the city's open drainage. Risk of pathogenic bacteria contamination to drinking water is anxious in the area due to the closed distance between the septic tanks and the wells as groundwater source for public consumption. In addition, the industrial wastewater treatment plant has also been promoted during the last two decades, however, many cases that the industries dispose their wastewater containing the pollutants that are not acceptable to environment.

Having the fact that integrated sludge management is the only means to resolve the problems due to the sludge overdosing. Therefore, there are at least four pillars of integrated sludge management that must be highly scrutinized, i.e., watershed management; solid waste management; fecal sludge management; and activated sludge management. Subsequently, the follow-up of implementation must be based on integrated planning and management, involving the entire stakeholders.

However, the economic instruments deal with efficiency of allocating resources must also be promoted as an effective tool for sustainable sludge management [5] although this matter is still appeared to be a sensitive subject for the rural communities. This is particularly the case relating the issues of role-sharing, cost-sharing and risk-sharing in the context of upper-middle-downstream watershed areas.

INSTITUTIONAL ARRANGEMENT

Considering the existing problems and constraints the institutional arrangement must consider the ways of trading-off between the river basin approach and the political administrative boundary approach which in most cases are not coincide to each other. For this purpose, there are three policies that must be set up by local autonomous government: (i) Zero ΔQ policy for maintaining the run-off; (ii) Zero ΔE policy for preserving the erosion rate; and (iii) Zero ΔP policy for safeguarding the pollution resulted from human activities.

Other more in implementing the Law No. 7 on Water Resources, to the government regulations relating the water resources management as well as the river and lake have been introduced in “the water pays water concept” wherefrom a part of which taking account the sustainable sludge management and for the long term frameworks programme it will be expectantly supported by self financing the water resources management in Indonesia. Three pay principles i.e., prevention, user and polluter pays should be adopted as the strategy in the next years to come. The prevention pays, principle pays most attention to preventing unwanted impacts regardless of who should pay. It is closely related to “precautionary principle” which aims at risk reduction and pollution prevention, and investing on a large central wastewater treatment facility is an example. User pays, principle pays attention to those overusing resources including water and it can be controlled for example by water user fee. And polluter pays, principle pays attention to those polluting the environment including water media, and adopting the wastewater fee or environmental fee can be contributed for reducing the pollution [5].

Involving the stakeholder participation for all activities, beginning from setting up the master plan as entry point and terminating by the operation and maintenance as ending point in the sludge sustainable management, should be considered into the frameworks of proposed sludge management programme including the stakeholder interaction mechanisms and developing the representative institutions. It is really important things because water as dynamic medium brought the sludge through the river basins from the upstream to the downstream areas and passing the diverse stakeholders. Therefore the water council at the river basin level as well as at the local and central government levels should be considered as an alternative coordinating board.

In the surface water of a river, sludge commonly expressed as suspended solids parameter which containing the organic matters as well as certain other pollutants. So that, in the fact, increasing the sludge in water pursuit the increasing the value of organic oxidizable matters such as indicated by BOD and COD and resulting some additional expenses of environmental and social costs in reducing the related pollutant problems for the peoples living in the downstream areas who used the water. Therefore, the internalization of external impact mechanisms as an economic tool should be adopted for involving the stakeholders under the sustainable sludge management frameworks in the future time and implementing the polluter pays principle gives a good illustration in this case.

As perspective programmes can be promoted to handling the erosion and sedimentation problems in the developing countries. Hence, the river basin upstream-downstream interaction mechanism gives a brilliant challenge to the sludge management in the next years to come where the concept is basically founded on the seller-buyer approach by consolidating the two parties of the basin. One part, by creating the community groups of the people who intervening to conserving the forest, land and water which living in the upstream area as the seller and, the other part, by confirming the people and/or capable institutions who used the water that locating in the downstream as the buyer. This concept is propagate adopted “the under win-win solution” and targeting to improve the livelihood of the up-stream’s poor people while insuring the quantity and quality of used water for multi-purposes in the downstream area.

The solid waste and fecal sludge as well as activated sludge of a wastewater treatment plant should be managed by the local government such as the municipalities or district authorities according the related political administrative boundaries. Whereas, reducing the sludge coming from soil erosion needs to be follow up with a systematically procedure and programme pursuant the integrated sustainable sludge management plan which setting up as a part of an integrated water resources management plan according the river basin hydrographical boundary. And the related institutions both cross-sector at the national and local government levels and cross-region entire the river basin may be involved to handling the recommendations to solve the all of related problems in conformity with the priority setting up in the legal master plan.

ALTERNATIVE FOR UTILIZATION OF SLUDGE FOR FERTILIZER AND OTHER PURPOSES

In general the sludge contains indispensable elements for plant growth that so it can be considered to use it in the agricultural activities by applying certain related technical methods to control the quantity of minerals and in preparing of the destined land field for dumping the activated sludge. In this regards, much of recycle and reusable technologies could be pursued to optimize the utilization of sludge as fertilizer in the agricultural purposes. Complementary to this, the fertile sludge coming from erosion is often used as fertilizer and can be collected to a target location by constructing a check dam and it is habitually founded in the upstream area of a river basin.

Nevertheless, the application of such technology must also be strictly controlled especially to use the activated sludge in the agriculture activities due to the possibility of containing the pathogenic microorganisms and in which could also contaminated by the harmful minerals that affecting the serious problems to the human health as well as contributing hazardous impacts to environment. And the utilization of sludge as building materials such as filled foundation materials is unexposed part of the construction and the likes are also opened into the research and development of its implementation in the coming years.

CONCLUSIONS

The underlying tendency of excessive sludge products by human activities including industries has brought about escalating of both positive and negative impacts to environment, particularly to the harmful effect to human and living ecosystem. In many occasions the problems of sludge has almost come to what is often refers to as the *"tragedy of the common"* that must be immediately put at the highest priority for mitigating the hazardous impacts. Unfortunately this matter has yet become internalized by the community members in many developing countries.

To this conclusion, the most apparent measure toward resolving problems – under the present problems and constraints of developing countries, including Indonesia – is by means of integrated sludge management, which first of all must starts from massive campaigning program to develop the public's sense of crisis, so that the communities as a whole are willing to participate in integrated river basin management. If this to be materialized, one may see before too long, the sludge management, as the inseparable side of the coin – of sustainable development and management – would become instrumental for materializing the desirable and sustainable balance of human, life and environmental ecosystem on Earth.

REFERENCES

- [1] Fulazzaky, M. A. (1992) Mesure de la DBO des lixivats de décharge – Evaluation de l'influence de certains facteurs sur la DBO, Travail de fin d'études, ENTPE – Laboratoire des Sciences de l'Environnement, Lyon, France
- [2] Planning Unit Team - Directorate General of Water Resources, (1998) Integrated water management plan for the Citarum river basin, Final Report, Jakarta, Indonesia
- [3] Koottatep T., (1999) Night soil treatment and management, International training course on water management, water supply and sanitation, Prince of Songkla University, Hat Yai, Thailand
- [4] Magsood Sinha, A. H. M. D., (1999) Solid Waste Management., International training course on water management, water supply and sanitation, Prince of Songkla University, Hat Yai, Thailand
- [5] Darnsawasdi, R and Roongtawanreongsri, S., (1999) Economic as a tool for sustainable water, wastewater and solid waste management, International training course on water management, water supply and sanitation, Prince of Songkla University, Hat Yai, Thailand
- [6] BPS Statistics – Indonesia, (2004) Environmental Statistics of Indonesia, Jakarta, Indonesia
- [7] Sukistijono, (2005) Erosion and sedimentation in Brantas upper reach and its countermeasures, First International Workshop on Water and Sediment Management on Brantas River Basin, Batu, Indonesia
- [8] Djajadiredja, E. A. and Ibrahim, A. B, (2005) Effect of land-use change on sedimentation rate at upper Citarum river basin, West Java Province, First International Workshop on Water and Sediment Management on the Brantas River Basin, Batu, Indonesia
- [9] Fulazzaky M.A., (2005) Problems and restoration activities for eutrophicated lakes and reservoirs in Indonesia, 56th IEC – ICID Meeting and 19th ICID Congress, Beijing, China

- [10] Directorate General of Water Resources, (2005) Water resources conservation problems in Indonesia, Ministerial Coordination Meeting among the Ministry of Public Works, Forestry and Environment, Jakarta, Indonesia